

With the Compliments of

N. Henry Crafts,

City Engineer.

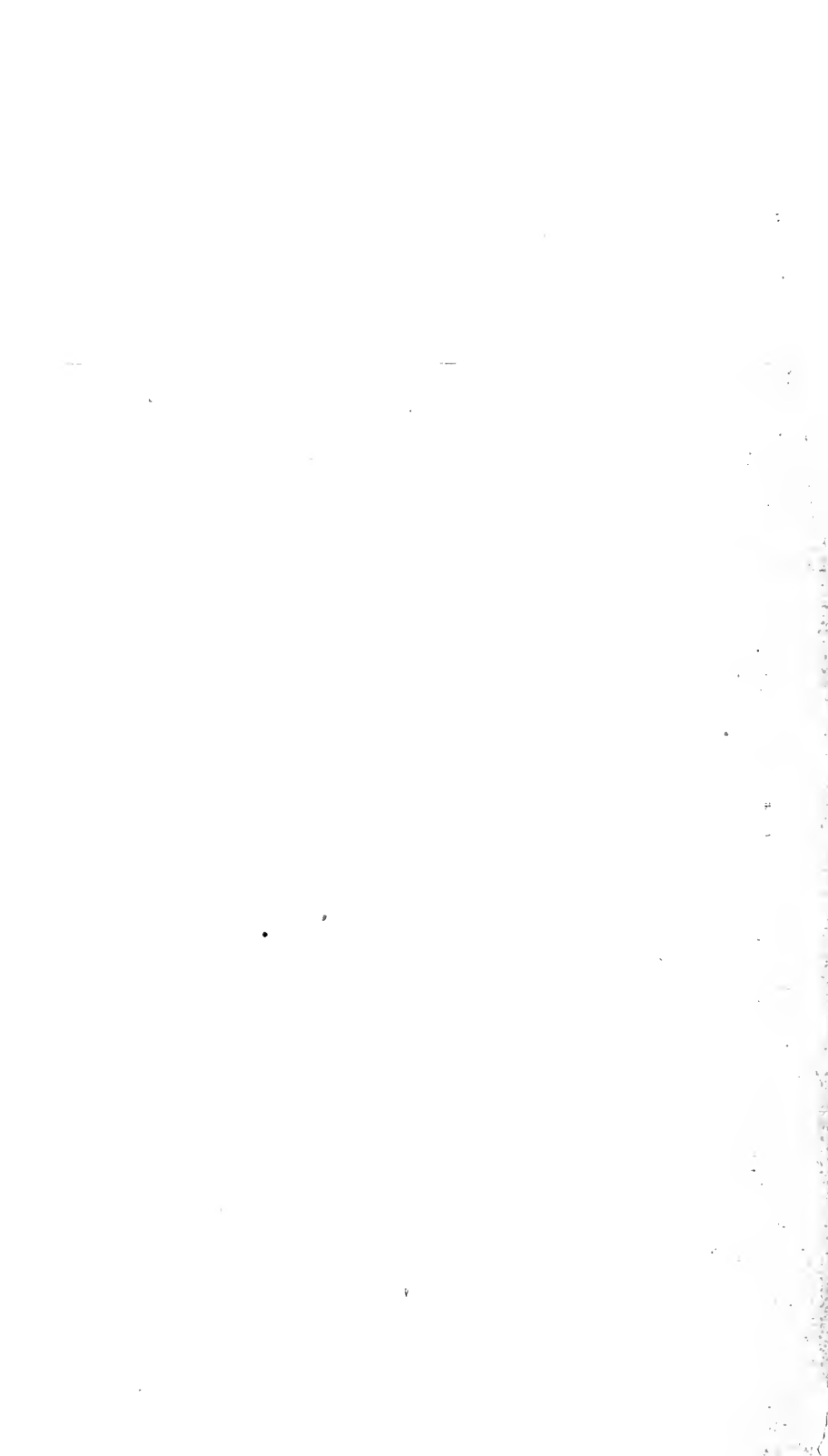


ANNUAL REPORT

OF THE

CITY ENGINEER.

9 1871.



City Document.—No. 15.

CITY OF BOSTON.



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OFFICE OF CITY ENGINEER, CITY HALL.

BOSTON, January 15, 1871.

To the Honorable City Council:

I have the honor to present, in compliance with the sixth section of the ordinance relating to the City Engineer's Department, the following report, viz:—

Statement of expenses of Department as paid from the department appropriation:

Balance of appropriation for 1869–70, expended from January to May, 1870.	.	.	\$3,452 88
Amount of appropriation for 1870–71.	.	.	15,000 00
			<hr/>
			\$18, 452 88

Salaries of City Engineer, assistants,

draughtsmen and rodmen	.	.	\$9,832 60
Instruments and repairs	.	.	648 40
Drawing paper and materials	.	.	632 83
Stationery, note books, etc.	.	.	444 13
Reference books, pictures and frames			216 35
Printing and advertising	.	.	157 50
Travelling expenses, horse-keeping,			
etc.	.	.	579 43
Horse, buggy, harness, etc.	.	.	775 00
Incidental expenses.	.	.	274 76
Expenses of Committee	.	.	584 89
			<hr/>
			14,145 89
Unexpended balance Jan. 1, 1871	.	.	<hr/>
			\$4,306 99
			<hr/>

The following statement shows the amounts paid since January 1, 1870, for engineering, from *special* appropriations: —

WATER WORKS.

Chestnut Hill Reservoir: pay-rolls and incidentals	\$4,017 22	
Roxbury extension (Wards 13, 14 and 15): pay-rolls and incidentals	745 29	
Deer Island water-pipe: pay-rolls and incidentals	484 42	
Dorchester extension and new main to South Boston	1,436 83	
East Boston: new flexible pipe across Chelsea creek	154 56	
	<hr/>	
Total,		\$6,838 32

PAVING DEPARTMENT.

Atlantic avenue: pay-rolls and inci- dentals	\$1,470 59	
Broadway extension: pay-rolls and incidentals	1,091 93	
	<hr/>	
Total,		\$2,562 52

SUFFOLK STREET DISTRICT.

Pay-rolls and incidentals	555 27
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MT. WASHINGTON AVENUE BRIDGE.

Pay-rolls and incidentals	620 38	
	<hr/>	
Total from special appropriations . . .	\$10,576 49	
Add amount paid from the Department appropriation	14,145 89	
	<hr/>	
Total for engineering in 1870	\$24,722 38	
	<hr/>	

The number of persons employed and paid from the department appropriation was on the 1st of January, 1870 (including the City Engineer)	13
The present number is	17
The Chestnut Hill party, on the 1st of January numbered	5

One of the assistants was transferred to the surveys for extension of the water works in Dorchester in May; but during a portion of the months of June, August, September and October, was recalled to Chestnut Hill.

On the 10th of November, the Chestnut Hill party was disbanded, — the last pay-roll being made up to that date. Two of the party remain connected with the department. The Resident Engineer, Henry M. Wightman, Esq., holds the position of Assistant City Engineer, and W. F. Learned, Esq., has the supervision of the extensions of the water works in Roxbury and Dorchester.

The following statement exhibits the operations of the department during the past year, and such general information relating to the various works and structures finished and in progress, as I have thought would be of interest, and comply with the provision of the ordinance relative to this report.

WATER WORKS.

Chestnut Hill Reservoir.

This great work, which has so largely exceeded in magnitude and cost the original designs and estimates, was so far completed on the 25th of October last as to be ready for the reception of water in the lower, or, as it is now called, the "Bradlee Basin." The engineering operations connected with this work, and extending over a period of seven years may, it seems to me, be appropriately recorded and described in this report, and be found of sufficient interest to warrant the occupation of the required space.

Surveys for a suitable site for this reservoir were made in 1863, and in November of that year three plans were submitted

to the Water Board. The first was a plan for a reservoir on the southerly side of the Woonsocket division of the Boston, Hartford and Erie railroad; the second was a plan of the site of the present Lawrence basin, and the third was a plan of the present Bradlee basin, but only included the portion on the northerly side of Beacon street, which then divided what is now the Bradlee basin. To this last plan was afterwards added the other portion of this basin, which was on the southerly side of Beacon street.

By the first plan a water area of but forty-one acres could be obtained, and that only by building a dam parallel to and adjoining the railroad, and this dam would, at the easterly end, have been twenty-four feet above the track, and the foundation for nearly the entire length of the dam was of the worst description, being of quicksand. By the second plan the water area was forty-four acres, but the depth of water would have been but twelve feet, which is not sufficient to prevent the growth of subaqueous vegetation. An excavation of five feet in depth, over nearly the whole extent of this reservoir, was necessary, and this was considered and afterwards proved to be a very expensive work.

By the third plan a water area of fifty-two and one-half acres could be obtained on the northerly side of Beacon street, and on the southerly side, an area of forty-one and one-half acres, the two forming a basin ninety-four acres in extent; this third plan was the one adopted by the Water Board upon my recommendation.

During the following year but little was done by this department in connection with the reservoir, with the exception of some further rough surveys and approximate estimates of the cost of doing the work.

In 1865, the City Council having made in 1864 an appropriation for the purchase of land for a site for the reservoir, and having procured an act of the legislature authorizing the

construction of the same, a party was detailed from this office, under the charge of Henry M. Wightman, who had made the previous preliminary surveys, to make an accurate survey of the whole territory and plans for the building of the reservoir. During the progress of these surveys, it was decided by the Water Board to connect the Lawrence basin with the site already adopted. The expense of draining this basin in a new direction, as its natural drainage would have been prevented by the construction of the reservoir upon the site selected; the difficulty of making the dam between the two perfectly tight, so that no claim should arise for damages from its owner; the question of damages which would probably arise for diverting the natural drainage, and beyond all these considerations, the desire of the Board and myself to construct a reservoir which should be ample to meet the future wants of the city, were the reasons for the addition of this basin to the original plan.

The area surveyed was about three hundred acres in extent. The property lines were carefully determined, and a complete topographical survey made of the whole territory. The plans were made with great accuracy and contour lines for every two feet in height were traced upon them. These plans were the basis for all the subsequent work upon the reservoir. The location of the banks was determined by means of profiles made at right angles to its proposed direction, upon which the most favorable position for the banks was fixed; these points were then transferred to the plans and connected by straight lines and curves which formed the lines for the reservoir banks. These lines were of course subject to alterations should the material in cutting or the foundation in filling prove them to be not the most economical. All the curves of this reservoir are regular, being either simple, compound or reversed, connected by straight lines.

The accuracy of these surveys and plans may be judged by the fact that the lines of the banks, driveway, etc., as laid out from the base lines of the survey and by scale measurements from the plans, rarely varied a foot.

These plans were not fully elaborated upon the commencement of the work upon the reservoir in the spring of 1866, as the party employed upon the work was small, and they were interrupted by the bad weather and the necessity of making plans and descriptions of the land bought, and by the sickness of the superintendent of the work, Mr. Knowlton, which rendered the presence of the Resident Engineer necessary at the site of the reservoir where arrangements were being made for constructing the necessary buildings, such as grading for the stables and boarding-house for the men, draining, and clearing the land of trees.

By working night and day upon the plans, they were completed so that no delay was occasioned in prosecuting the work on the reservoir. The plans for the location of the banks having been completed, the question of disposing of the surface water drainage remained to be settled, there being considerable diversity of opinion upon the subject. Two plans were finally submitted, embodying the different views. By one of these plans it was proposed to divide the drainage at the Lawrence brook, and to convey one portion in a northerly direction in an open catch water drain a distance of 2,100 feet, from which point a brick drain was to conduct it under the conduit, a distance of two hundred feet, and then an open catch water drain a further distance of 1,235 feet to Chandler's ice pond.

The other portion of the drainage was to be conveyed in an easterly direction and on the same route occupied by the present drain, but was to have been an open catch water drain for a distance of 2,200 feet, and a brick drain for the balance of the distance (about 3,800 feet) to the brook near the intersection of Beacon and Rockland streets.

By the other plan submitted, the drain was to commence at the influent Gate House and continue entirely around the reservoir on the westerly, southerly and easterly sides to the brook near the intersection of Beacon and Rockland streets, a distance of 7,754 feet. It was to be built of brick, underground the entire

distance, and varying in size from two feet six inches in diameter to six feet four inches diameter, with suitable catch basins and inlets for the water. This latter plan, although much the more expensive, was after careful consideration of the subject adopted, and the work commenced on the 10th of May, and the entire drain was completed on the 27th of November, 1867.

The building of a driveway around the reservoir having been agitated during the summer of 1866, and proving to be very popular with the citizens, several plans and estimates were submitted to the Water Board by the engineer. There was great diversity of opinion upon the subject in the Board, some of the members being opposed to the project, and others differing in their views as to the proper width to construct it. The engineer was finally directed to prepare a plan and estimate upon the best location that could be selected, and of a width not less than eighty feet. In preparing this plan the engineer ascertained that in some places the width of eighty feet would greatly add to the expense of the driveway, and having represented to the Board that a width of sixty feet in some places would greatly lessen the expense, a committee of the Board, consisting of Messrs. Norcross and Bradlee, were appointed to go over the proposed location, which had been staked out, and decide upon the width at these places.

This committee having attended to their duty, a plan and estimate was made, and submitted to the Board, and by them recommended to the City Council, who on the 9th of October, 1866, passed the necessary orders for its construction.

This driveway is constructed upon the plan of the Central Park roads, but differs from them in having a greater thickness of rough stone for the lower stratum, and a less thickness of crushed stone and gravel for a top dressing.

Plans showing all the details of the gate houses were made in this office, and the specifications for the cut granite and for building the gate houses were made in 1867, and the interme-

diat gate house was commenced. Before the work upon this gate house began, it was necessary to remove four hundred feet of the conduit, and convey the water around the gap thus formed, that there should be no interruption of the supply to the city.

This object was accomplished by the construction of a wooden flume, the plans for which were made by the Engineer, and so built as to be readily taken apart and put together again in any place where needed. Some difficulty was experienced in making its connection with the conduit perfectly tight, but by a liberal use of puddling clay, this object was accomplished and the flume was in constant use for about two years, and was then taken apart and is now stored at the reservoir.

Surveys and plans for the main pipes from this reservoir were made during the fall and winter of 1867 and spring of 1868. In order to select the most favorable route, and to show the various routes proposed, a tract of country was surveyed from Rockland street in Brighton, to Cypress street in Brookline, and between Boylston street, and Tappan street, and the Woonsocket Division of the Boston, Hartford & Erie R. R. and Beacon street, an area about one and one-half miles long by one-quarter of a mile wide, all of which was levelled over, and a topographical plan made upon which was laid out no less than five distinct routes. Profiles and cross-sections of these were made and submitted to the Water Board, and the route No. 5, on the general plan, showing the routes, was finally decided upon. Some additional surveys were made to show the feasibility of constructing a road over this route, and several propositions were made by the Water Board to the town authorities of Brookline; but the project was finally abandoned, and the land necessary for the pipe route was taken, under the act of the legislature, giving the city authority to lay the pipe.

In addition to these special surveys, the current work at the reservoir was continued without intermission. Lines and grades were given for every piece of embankment, for the drain, the

main pipe, the gate houses, driveway, etc., and a constant supervision exercised by the engineer over the work, that no unsuitable material should be used in the embankments or gate houses, and that the construction should in all cases conform to the plans. Monthly estimates were made of the amount of slope wall built, the amount of clay delivered for puddling, and of coping stone for the slope wall. Estimates involving a great amount of labor were made at three different times, of the cost of completing the reservoir. Levels were taken over the bottom of both basins, and their capacity calculated for each inch in depth, and tables made containing the length of water line, area and capacity for each inch in depth, and the total capacity for each inch in depth.

In addition to the work done at the reservoir, plans, specifications and contracts were drawn in this office for building the gate houses, for the main pipe and its connections, for the stables and other temporary buildings at the reservoir.

The engineering force at this reservoir consisted for the larger portion of the time of the resident engineer, one assistant engineer, two rodmen and one axeman, which was, I think, smaller than any force ever employed on a work of its size and importance.

The resident engineer was twice obliged to change his assistant, once by the illness and subsequent death of his assistant Samuel C. Horn, and the second time by a severe accident to his assistant Wilbur F. Learned, who while giving a line for the building of the effluent gate house, fell from the wall, a distance of about twenty feet, causing such injuries that he was disabled for a period of six or seven months.

The lower, or Bradlee basin of this reservoir was completed and the water let into it on the twenty-fifth of October, 1870, and the branch office of this department at the reservoir, for five years under the charge of Henry M. Wightman, the resident engineer, was discontinued on the 10th of November.

HIGH SERVICE PUMPING WORKS.

These works were completed in February last, and the engines first started February 25th, to supply the Highland district. On the 4th of June, the Beacon-hill high service district was connected to test the pipes and play the fountain on the common. On the sixth the supply was regularly commenced, and, except for occasional repairs, has continued to the present time. A description of the manner of connecting the two districts and other details relating thereto, will be found in my annual report to the Cochituate Water Board in May last (City Doc. No. 51). From the engine records, I have compiled the following table, which exhibits the operations of the pumps since the first of March: —

Statement of Operations at the High Service Pumping Works, from March to December, 1870.

	Total pumping time.			Daily average pumping time.		Daily average amount pumped.	Hourly average amount pumped.	Average maximum hourly draft.		Average minimum hourly draft.		Greatest hourly draft.	Least hourly draft.	Average No. of revolutions per minute.	Average amount coal used per day.	Percentage ashes and clinkers.	Quantity pumped per pound of coal.
	Days.	Hours.	Min.	Hours.	Min.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.		lbs.		Gall'ns.
March . . . . .	..	51	21	1	40	46,694	..	..	..	..	..	..	..	9	1,000	22.9	47
April . . . . .	..	47	18	1	34 ⁶ ₁₀	47,000	..	..	..	..	..	..	..	10.67	895	18.7	52.5
May . . . . .	..	71	45	2	23 ¹ ₂	82,640	..	..	..	..	..	..	..	12.25	785	18.6	105.27
* { June 1st to 5th	25	19	5	3	41	128,479	..	..	..	..	..	..	..	12.37	823	18.2	156.
	..	..	..	23	40	575,489	23,020	40,914	18,900	47,282	14,565	..	..	10.85	2,041	..	282.
July	29	14	8	22	54 ¹ ₂	634,200	27,685	37,200	16,028	43,381	11,066	..	..	9.82	1,986	20.5	319.
August	30	7	40	23	28 ¹ ₂	651,842	27,770	37,957	17,490	46,463	14,288	..	..	9.85	2,089	18.8	312.
September	30	..	..	..	..	666,303	27,763	39,486	16,679	44,368	14,100	..	..	9.85	2,284	20.5	292.
October	31	..	..	24	..	633,794	26,408	38,753	16,247	47,000	14,570	..	..	9.36	2,164	19.4	293.
November	29	13	15	23	38 ¹ ₂	654,379	27,679	41,295	18,082	49,679	15,040	..	..	10.55	2,129	20.1	307.3
December	31	..	..	24	..	735,274	30,636	43,299	21,243	56,447	18,800	..	..	10.86	2,532	20.4	290.4

* The regular supply to Beacon Hill commenced on Monday, the 6th.

This table presents some interesting and rather important facts relative to the amount of water pumped, either to supply waste or leakage. From June 6th to January 1st, there has not been a single hour of the day or night (except when the water was shut off for repairs), that it has not been found necessary to keep the pumping engine working to maintain the proper level in the stand-pipe; and the least draft in any single hour during the aforesaid period of over six months, was 11,066 gallons on the 13th of July, between the hours of one and two A. M., an amount equal to 40 per cent. of the hourly average for the entire month. But a fairer comparison would be, to take the average of the smallest hourly drafts in each month, and compare that with the hourly average for the whole term of nearly seven months. From this comparison it will appear that the average of the smallest hourly drafts in each month, is 17,810 gallons, and the average hourly draft for the whole term is 27,280 gallons. In this case the percentage is increased from 40, as before stated, to $65\frac{1}{4}$. It is manifestly impossible that such an amount of water can be required for legitimate uses, and that it must be attributed to careless or wanton waste, or to leakage in the gates which separate the high and low service districts. I am of the opinion that both causes contribute to the unparalleled results of night consumption indicated by the foregoing figures; but that the leakage above referred to is the chief cause. If this be so, then we have not absolutely lost or used the water; but have pumped, probably, double the amount required to amply supply the entire high service.

The daily average amount of water pumped for the high service since June 6th, when the Beacon-hill district was connected, was 650,200 gallons to supply a population of not over 10,500 at a liberal estimate, and where the requirements are almost exclusively for domestic uses. Compare this rate of consumption with that of East Boston as determined by observations recorded in the following table which I transcribe from

my annual report to the Cochituate Water Board in May last (City Doc. No. 51),—bearing in mind that the East Boston observations were made in severely cold weather when there would naturally be some waste to prevent freezing; and remembering also that, the East Boston district requires a very considerable amount of water for manufacturing and shipping interests.

Consumption of water in East Boston from observations taken at East Boston Reservoir, from 9 o'clock, A. M., Dec. 24, 1899, to 9 o'clock, A. M., Dec. 25, 1899.

Time.	Depth.	Consumption Galls. per hour	Total Con- sumption.
December 24.	ft. in.		
9 o'clock, A. M.	20 11	. . . .	. . . .
10 " "	20 8	68,233	68,233
11 " "	20 5	67,642	135,875
12 " M.	20 3	44,769	180,644
1 " P. M.	20 1	44,509	225,158
2 " "	19 11	44,250	269,403
3 " "	18 9	43,989	313,392
4 " "	19 7	43,731	357,123
5 " "	19 6	21,769	378,892
6 " "	19 3	64,921	443,813
7 " "	19 2	21,512	465,325
8 " "	19 1	21,448	486,773
9 " "	18 11	42,704	529,477
10 " "	18 9	42,448	571,925
11 " "	18 8	21,129	593,054
12 " M.	18 7	21,065	614,119
December 25.			
1 o'clock, A. M.	18 5	41,940	656,059
2 " "	18 4	20,875	676,934
3 " "	18 4	. . . .	676,934
4 " "	18 4	. . . .	676,934
5 " "	18 2	41,561	718,495
6 " "	18 0	41,307	759,802
7 " "	17 9	61,489	821,291
8 " "	17 7	40,679	861,970
9 " "	17 6	20,245	882,215
Total,		882,215	

“It appears from the foregoing table, that the average hourly night draught from 9 o'clock, P. M., the 24th, to 4 o'clock, A. M., the 25th, was 15,000 gallons; that there were only two hours during the whole twenty-four when the observation indicated no draught; that the average hourly draught during the seventeen hours, not reckoned above as night hours, was nearly 46,000 gallons, and the maximum hourly draught was from 9 to 11 A. M., and from 5 to 6 P. M., the 24th, and from 6 to 7 A. M., the 25th — the average of the four hours being 65,571 gallons.

The total for the twenty-four hours was 882,215 gallons, and, calling the population 25,000, the consumption per head would be about thirty-five gallons.”.

By reference to the preceding table of operations at the high service pumping works, it will be seen that the daily average amount pumped in December was 735,274 gallons, an amount equivalent to seventy gallons per inhabitant, or just double the rate per head actually used in East Boston as per the foregoing table.

Observations, continued for more than a year, of the amount of water actually used, as determined by meter measurement, in seven different families, (members of the Water Board) show an average consumption of twenty-five gallons per head in twenty-four hours. In the estimates which I submitted to the Water Board in May last of the probable requirements of the Beacon-hill high service, I mapped out the proposed district and procured from the Water Registrar a schedule of all the establishments within the district using the water, and the number of occupants in each dwelling-house, tenement house, hotel, etc. The population of the district as thus determined was called, in round numbers, 6,000 and I allowed forty gallons per day to each inhabitant, making the daily requirements 240,000 gallons.

The district was subsequently enlarged, but to a very limited extent, and if I were to revise that estimate to conform to the enlargement, I should simply add to that amount, (240,000 gallons,) the amounts actually used by all the hotels, restaurants, club-houses, tenement-houses, and public buildings, using large

quantities as determined for the past year by meter measurement. This amount, as kindly furnished by the Water Registrar, amounts to 68,200 gallons per day. The amount would then be, 308,200 gallons per day. If to this we add the average amount actually pumped per day for the Highland high service, as shown by the records for May, before the Beacon-hill district was added, which was 82,640 gallons; the total requirements would then be, 390,840 gallons per day, by a most liberal estimate, and only fifty-three per cent of the average daily amount actually pumped in the month of December. There are probably fifty gates in all, required to separate the high and low service, with a difference in pressure on the two faces of forty pounds, and upwards, per square inch; and, unless all these gates are perfectly tight, it is evident that, with such a pressure, the leakage must be very large from the high to the low service; and it is this, in my judgment, and not a wasteful use, that causes the enormous requirements of the high service.

The pumping records show that the hour of greatest draft generally falls between eight and nine o'clock A.M., and that the hour of least draft, between the hours of two and three o'clock, A.M. Thinking it might be interesting to know the relative consumption on different days of the week, I have taken considerable pains to compile the following statement:—

Statement of the average daily number of gallons of water pumped for the high service supply on each day of the week from June to December inclusive, arranged to illustrate the comparative draught on the several days of the week.

Month.	Monday.	Tuesday.	Wed'sday	Thursday.	Friday.	Saturday.	Sunday.
June,	745,479	687,234	706,661	678,977	654,786	726,683	543,731
July,	692,948	661,949	624,600	644,927	662,916	640,528	603,872
August,	697,554	650,037	657,276	661,854	677,322	700,084	593,043
September,	703,837	676,603	667,870	668,592	650,756	687,680	608,007
October,	674,927	630,176	643,465	625,271	630,166	660,488	582,132
November,	733,435	647,908	668,926	656,801	647,378	683,296	598,915
December,	791,826	729,510	732,213	711,101	725,097	765,788	692,345
Averages,	720,001	669,600	671,573	663,932	664,060	694,935	603,149

From the foregoing statement it appears that the days of the week arranged in the order of the greatest average consumption stand as follows:—

No. 1.—Mondays,	average	.	.	.	720,001	galls.
No. 2.—Saturdays,	"	.	.	.	694,935	"
No. 3.—Wednesdays,	"	.	.	.	671,573	"
No. 4.—Tuesdays,	"	.	.	.	669,600	"
No. 5.—Fridays,	"	.	.	.	664,060	"
No. 6.—Thursdays,	"	.	.	.	663,932	"
No. 7.—Sundays,	"	.	.	.	603,149	"

The average consumption on Mondays is $19\frac{4}{10}$ per cent. greater than on Sundays, and about 8 per cent. greater than the average of the Tuesdays, Wednesdays, Thursdays and Fridays, which do not vary much from each other.

Before the Beacon-hill high service district was connected, the night consumption (from twelve o'clock midnight to five A. M.) was found to average ten per cent. of the day consumption.

Since the Beacon-hill district was connected the proportion of night to day consumption has increased to twenty per cent.

BEACON-HILL HIGH SERVICE.

The surveys and plan referred to in my last annual report as being then in progress have been completed, and a full description of the same, and of the method of supplying the district, may be found in my annual report to the Cochituate Water Board in May last.

SOUTH BOSTON HIGH SERVICE.

During a portion of the months of August and September a party under the charge of Wilbur F. Learned were engaged in surveys to locate the buildings and determine the elevations of all door-sills above a plane of fifty-five feet above "tide marsh level." A plan was subsequently prepared similar to that of the Beacon-hill high service, and an estimate of the cost submitted to the Water Board, of supplying the necessary pipes, gates, etc. to connect the present pumping engines with this district, and separate the high from the low service. The following is a copy of the estimate then submitted, viz: —

OFFICE OF CITY ENGINEER, CITY HALL.

BOSTON, Sept. 7, 1870.

N. J. BRADLEE, ESQ.

President Cochituate Water Board.

Dear Sir : — The following report and estimate relative to supplying the high service of South Boston by the pumping engines, is respectfully submitted. I have drawn the division line between the high and low service substantially as in the case of the Beacon-hill high service, — that is, to include all houses in the high service whose door-sills are at a level of fifty-five feet or more, above "tide marsh level." The districts are shown on the plan herewith submitted, and the number of houses in each. The Independence-square district has only twenty-two houses whose door-sills are above grade 55, and the highest one is at grade 69. This district is all built over. The Telegraph-hill district has three hundred and seven houses whose door-sills are above grade 55, and the highest one is at grade 108. The vacant land in this district will

accommodate three hundred and fifty more houses, so that ultimately there may be in this district six hundred and fifty-seven houses. The present requirements of these districts I estimate at about 120,000 gallons per day, and the ultimate requirements about 200,000 gallons per day. In estimating the size of pipe required to supply the ultimate requirements, I have assumed a maximum draught per hour of thirty gallons per house, which is the amount determined by actual measurement at your house on a washing day. If this draught were kept up for the entire twenty-four hours, the amount consumed would be about 500,000 gallons.

The route for the supply pipe is from the 30-inch main at Tremont street; thence through Dover street over the Dover-street Bridge, and through Fourth street and connecting with the distribution pipes on the easterly side of Dorchester street. The distance is about 7,500 feet.

I find by calculation that an 8-inch pipe of the above length will deliver the maximum amount required as above stated with a loss of head of about twenty-five feet. Assuming the average effective head on the 30-inch pipe to be two hundred feet (and it will be more than that, if the stand-pipe were kept full), — then deducting the loss by friction in the 8-inch pipe, there will be an effective head on the high service distribution pipes of one hundred and seventy-five feet above “tide marsh level,” and as the highest cistern now is about one hundred and fifty feet above said level, there will still be a surplus head of twenty-five feet above the present highest house, and with the stand-pipe full, this would be increased some twenty or more feet.

I am of the opinion, therefore, that an 8-inch pipe will serve amply all the future needs of the South Boston high service.

APPROXIMATE ESTIMATE OF COST OF HIGH SERVICE WORKS.

7,500 feet of 8-inch pipe	at \$2.75	\$20,625 00
Syphon at Dover-street Bridge		7,500 00
3,245 ft. of 6-inch pipe within the districts	at \$1.75	5,678 75
1,700 “ “ 6-inch pipe to connect the districts	“	2,975 00
420 “ “ 4-inch pipe	at \$1.25	525 00
25 6-inch gates all set complete	at \$60.00	1,500 00
1 4-inch gate all set complete	at \$45.00	45 00
4 8-inch gates all set complete	at \$75.00	300 00
		<hr/>
		\$39,148 75
Say in round numbers		<hr/>
		\$40,000 00

Should the high service pipes in Dorchester be extended to supply the high districts on Meeting-house and Jones's hills, the proposed 8-inch pipe for South Boston could be connected at Jones's hill instead of at Tremont street. In that case the length of 8-inch pipe required would be about 8,000 feet; but the cost of a syphon would be saved, and as the route is unpaved, there would be about forty cents per running foot saved on the entire length of 8-inch pipe. These two items would reduce the foregoing estimate, making the cost by the Dorchester route about \$9,000 less than the Dover-street route.

(Signed)

N. H. CRAFTS,
City Engineer.

It was decided by the Water Board, and approved by the City Council, that it would be inexpedient to incur so large an expenditure, until the efficacy of the new 20-inch main had been tested.

DEER ISLAND WATER PIPE.

In my last report I alluded to certain questions which had delayed action in the work of laying the pipe to Deer Island as authorized by an order passed 1869.

The question of what sized pipes would be requisite under certain contingencies, such as the location of the lunatic asylum at Winthrop, and the providing of an adequate fire supply at a proper elevation to suppress fires at Deer Island, were then under consideration by me, and a full report on the subject was made to the Water Board, February 16, 1870, in which I recommended certain changes in the size of pipe previously estimated upon, — and presented a variety of calculations bearing upon the question of the comparative loss of head involved in supplying a definite quantity of water to Deer Island in a given time, through different sized pipes, arranged in various ways, in order to determine what arrangement of them would supply the required amount with the least sacrifice of head, and not exceed in cost the amount already appropriated. The Chief Engineer of the Fire Department was consulted as to the

proper supply in that locality, in case of an extensive conflagration, and he thought two hundred gallons per minute, delivered above the highest part of the building, would be an ample supply. As two hundred and twenty-five gallons per minute amounts to just one-half a cubic foot per second, a quantity convenient to use in the calculation, I used that amount as representing the maximum requirements.

The calculations made it evident that a single line of six-inch pipe, upon which the first estimate was based, would be inadmissible, as the total loss of head involved in delivering the required amount in the given time would amount to one hundred and fifty-two feet.

From seven other assumed cases, I selected the one which has been substantially followed so far as the sizes of the pipe are concerned, — but the recommendations which I made, relative to using wrought-iron cement-lined pipe for the sizes below twelve inches in diameter, in order to keep within the amount appropriated, the Water Board, after investigation and inquiry, thought it unadvisable to follow; therefore an additional appropriation to cover the cost of cast-iron pipe of increased size was asked for, and \$21,000 was granted, making the whole appropriation \$75,000.

The plan which I proposed was as follows:—

1st. Lay that portion of the line which is within the limits of East Boston (from Chelsea street to the Causeway,—4,700 feet) with twelve inch cast-iron pipes, and pay the expense from the current annual appropriation for the Water Works.

2d. From the easterly end of the aforesaid twelve inch pipe lay 9,070 feet of ten inch wrought-iron cement-lined pipe to Beach street in Winthrop.

3d. From Beach street to “Shirley Gut” lay 11,405 feet of eight inch wrought-iron cement-lined pipe.

4th. Across the “Gut” from low-water to low-water lay about two hundred and fifty feet of cast-iron flexible-jointed six inch pipe (Ward’s joint).

5th. From low-water on Deer Island to the southwest corner of the House of Industry about 1500 feet six-inch cement-lined pipe.

The estimated cost of the work as above proposed, below the limits of East Boston, was \$53,613.90.

The changes which have been made from the foregoing plan are as follows:—

1st. The entire line is laid with cast-iron pipe.

2d. Instead of a single line of six-inch pipe across "Shirley Gut," a double line of eight-inch pipe has been laid, connected by suitable branches above high-water mark and provided with gates so that either or both lines can be used or cut off entirely.

3d. Instead of 1,500 feet of six-inch pipe on Deer Island there has been laid 3000 feet of eight-inch pipe.

In July a contract was made with Mr. George H. Norman, a widely known contractor and builder of Gas and Water works, to furnish and lay the pipes of the following sizes and weights, and approximately of the lengths prescribed, viz:—

2,000 lineal feet of 12-inch pipe to weigh 75 lbs. per foot											
9,070	"	"	10	"	"	"	"	65	"	"	"
11,405	"	"	8	"	"	"	"	42	"	"	"
1,500	"	"	6	"	"	"	"	33	"	"	"

A double line of six-inch flexible-jointed pipe across the "Gut" from Point Shirley to Deer Island, said flexible pipe to be of such style or pattern as shall be satisfactory to the city engineer. The contractor was also to furnish and set all gates, hydrants, branches, blow-offs, and air-cocks, the city to furnish the gates and hydrants, and the necessary boxes and covers.

The entire work was to be completed on or before the 1st of October, and the amount to be paid \$60,000.00.

A provision is made for allowances for deviations in the lengths of the several sizes of pipes, from the foregoing schedule.

Unavoidable delay in procuring the pipe, has prevented the finishing of the work, and there still remain a few connections to be made before the water can be let on and the pipes tested.

The amount of pipe laid on the island to the present time, is 2000 feet of eight-inch. The field work in connection with this line of pipe, has been under the charge of Mr. Henry Manley, who has staked out the entire line, given the grades, and kept account of the lengths of the different sizes laid.

In addition to this work, Mr. Manley has made the necessary surveys and plans to determine and exhibit the manner of distributing the water at the Island, and to locate the hydrants.

The work of laying the submerged pipe across the Gut, was sub-let to John F. Ward, C. E. of Jersey City, the patentee and proprietor of a ball and socket joint, which has been successfully tested in various parts of the country. The pipes were put together on the beach at Point Shirley, and by means of a cable attached to a capstan-windlass placed on the Deer Island side, both lines were successfully laid.

This part of the work occupied only a few days, and was done in October.

EXTENSION OF THE WORKS IN ROXBURY.

Early in the year, a schedule was prepared of all the pipes, hydrants, gates, etc., that would be required to complete the entire distribution of the water in this section of the city. This schedule was carefully examined, and compared with the map, by Mr. Lewis of the Water Board, Mr. Jones, Superintendent of the Eastern Division, and myself, and a reduced schedule, covering such streets and sections as in our judgment would pay six per cent interest on the cost, was prepared. This latter schedule was still further cut down with a view of closing the special extension account, and defraying the expense of all further extensions in the district from the annual current appropriations.

This idea, however, did not find favor with the City Council, and a special appropriation of \$125,000.00 was made in April to cover the cost of the extension of the works in Roxbury. Had a special appropriation been asked for early in the year in accordance with the schedule then prepared, a considerable saving of time would have been made and contracts for the necessary pipes made in season to have avoided the delay in their delivery, which occasioned so much inconvenience in the execution of the contemplated work.

During the year the lot on which the stand-pipe was built, now called Highland Park, has been partly graded, a driveway and footpaths built; and a retaining wall on the Fort avenue side. Surveys and plans were made to facilitate an exchange of land between the city and S. M. Allen, on the easterly side of this Park, and considerable time was given to setting out lines and grades for the improvements at this locality.

All the water-pipes laid in Roxbury during the year have been measured, and their positions, with all gates, hydrants, branches and air-cocks, located and delineated upon the plans in the office. Special plans, upon a large scale, have also been made of the more complicated connections showing the exact position of the different sized pipes, gates, etc., with reference to well-defined surrounding objects. These plans enable the superintendent or his assistants to locate and find any desired gate without liability to mistake, and also to see at a glance the arrangement of the connections.

The following is a statement of the work done by the Superintendent of the Eastern Division as measured by this department from Jan. 1, 1870, to Dec. 31, 1870, inclusive:—

PIPES.

24-inch pipe	.	.	.	.	1,361 feet
(1,287 ft. Dorchester Main; 74 ft. Beacon-hill High Service.)					
16 "	"	.	.	.	2,873 "
12 "	"	.	.	.	10,966 "
6 "	"	.	.	.	17,592 "
4 "	"	.	.	.	8,649 "
Total					41,441 " about $7\frac{8}{11}$ miles.

GATES.

30-inch gates	.	.	.	1 for Beacon-hill High Service
24 "	"	.	.	1 " " " "
16 "	"	.	.	3
12 "	"	.	.	17
6 "	"	.	.	38
4 "	"	.	.	22
Total				82

HYDRANTS.

Lowry Hydrants	.	.	90
Lowell "	.	.	6
			96

All the engineering field-work connected with this section has been under the control of Henry Manley, Esq.

EXTENSIONS OF THE WORKS IN DORCHESTER, WARD 16.

The surveys alluded to in my last report as then in progress, consisting of the location of all houses and buildings likely to require water; the determination of the heights of the door-sills of all buildings higher than fifty feet above "tide marsh level"; the taking of levels of all streets and making profiles of the same; the defining of the dividing line between high and low service, etc., were continued under the direction of Henry Man-

ley, Esq., with frequent interruptions on account of the weather, and the pressure of current work until May, when Mr. W. F. Learned, from the Chestnut Hill Reservoir corps, with a special party, was assigned to the control of the completion of the surveys, and also to give lines and grades for laying the pipes and keep a record of all pipes laid, gates and hydrants established, and delineate the same on plans prepared for that purpose. As before stated, Mr. Learned was unavoidably called away to Chestnut Hill Reservoir during a portion of June, August, September and October; and also to make surveys for the proposed South Boston high service; and although the current work in the Dorchester district — such as giving lines and grades for laying pipes, keeping the record as before described — has been kept up, the progress of the surveys has been materially retarded. About twenty miles of roadway have been levelled over, and profiles of streets to the number of fifty have been made. This work will be continued the present season until finished.

By the kindness of Thos. W. Davis, Esq., City Surveyor, I have been permitted to copy the plans of the streets of Dorchester which have been made under his direction. These plans are drawn to a scale of forty feet to an inch, and have been of great use in the laying out of the work, and the position of the pipes, gates, hydrants and complicated connections can be very clearly delineated upon them.

There have been 16 of these sectional plans copied, covering the entire section of Dorchester in which it is proposed to lay the water pipes the coming season.

Early in the year I prepared a plan for the general arrangement of the water pipes, gates, hydrants, etc., and made a schedule of the requirements. From this I made out a list of those streets or portions of streets in which the water would probably be taken, and submitted the same with a rough estimate of the cost to a committee of the Water Board. Circulars were

distributed over this district with a view to ascertain the probable number of water-takers. The total number of responses was five hundred and six, of which one hundred and seventy-four answer *yes*, two hundred and six answer *no*, and one hundred and twenty-six are doubtful.

The petitioners in this district were not satisfied to have these returns accepted as a sufficient basis for a refusal on the part of the Board to extend the pipes.

By invitation, the premises of the petitioners and the section canvassed as aforesaid were visited by the Board and City Engineer, and the imperative necessity for the water by several manufacturing establishments was made clearly apparent. I was directed to complete with all despatch the plan then in progress showing the location of buildings within certain lines, and to submit an estimate of the most economical method of distributing the water, and the probable income.

Accordingly on the 1st of June, I submitted a plan and an estimate. A copy of the latter is herewith submitted as follows, viz:—

OFFICE OF CITY ENGINEER, CITY HALL.
BOSTON, June 1st, 1870.

N. J. BRADLEE, Esq., *President Cochituate Water Board.*

Sir:— I present herewith a plan of Dorchester, showing the number and location of buildings on that portion of the low service where there is a probability that the water will be taken; also the location and size of distribution pipes which would be required to supply the district aforesaid.

I have included only such streets and portions of streets as would pay six per cent interest upon the cost of a six-inch cast-iron distribution pipe, calling the cost of the same \$1.80 per running foot all laid, and reckoning an income from each house of \$10 on an average.

The total length of 12-inch pipe required as per this plan is 53,270 feet; of 6-inch pipe about 46,000 feet. The population of this district, I have estimated at from 8,000 to 10,000; the present requirements not over 500,000 gallons per day, and the prospective requirements ten years hence, allowing an annual increase of five per cent in the popu-

lation, at 900,000 gallons. To supply this amount I have provided two 12-inch feeders, one through Stoughton, Pleasant and Savin Hill streets, to Dorchester avenue; the other through Norfolk avenue and Cottage street to Dorchester avenue. These two pipes will be ample for all the requirements for ten years, and probably before that time another line from Grove Hall avenue through Quincy street, will form an additional feeder; so that, in my judgment, no larger main will be required for this section for ten or more years. I submit the following estimates of the cost of laying the aforesaid lengths of pipe.

ESTIMATE NO. 1 (CAST-IRON).

53,270 feet of 12-inch cast-iron pipe . . .	at	\$4.00,	\$213,080 00
46,000 " 6 " " " . . .	"	1.80,	82,800 00
300 Lowry hydrants complete . . .	"	110.00,	33,000 00
Gates, etc.			10,000 00
			<hr/>
			\$338,880 00

ESTIMATE NO. 2 (CEMENT-LINED PIPES).

53,270 feet of 12-inch wrought-iron and cement, at \$2.60,	\$138,502 00
46,000 " 6 " " " " " 1.40,	64,400 00
300 Lowry hydrants complete. . . at 110.00,	33,000 00
Gates, etc.	10,000 00
	<hr/>
	\$245,902 00

In the foregoing estimates I have reckoned the number of hydrants at the full proportion as established in Roxbury, viz: one to about every three hundred feet. So large a number of hydrants is undoubtedly not required at present; but it may be a question whether it would not be economy to locate and establish them as the pipe is laid. The number of houses, stores, factories, etc., in the district in question, is 1,335, and it is not unreasonable to assume that, in two years, the income from these houses, etc., will amount to \$15,000.

The income from hydrants will more than cover the interest on *their* cost. So that, if we call the cost of laying the pipe and establishing the gates, as per estimate No. 1 (reckoning *all* the pipes as six-inch), \$188,686; six per cent will be \$11,321 16.

If wrought-iron and cement pipe be used, the *entire* cost of pipes and gates will be \$212,902 (not reckoning the twelve-inch as six-inch) and six per cent of this will be \$12,774.12; while if the estimate of cost be based on *all* six-inch, it would amount to \$148,978; six per

cent of which is \$8,938.68. From all the information I have been able to gather in regard to wrought-iron and cement pipe, I am satisfied that, when properly made and laid, using good materials, and under proper restrictions as to supervision, it is as good, if not better, than cast-iron; and that, under such conditions, the use of this pipe cannot be pronounced an experiment. At all events, if, as in the present case, a saving of nearly \$100,000 can be effected, it seems to me that it is worth while to let a Committee of your Board, and the Superintendent of the Eastern Division, investigate the matter and report.

Very respectfully yours,
(Signed)

N. H. CRAFTS,
City Engineer.

A petition was subsequently presented to the Board of Aldermen by residents of Ward 16, asking for an extension of the water-pipes into that Ward. This was referred to the Committee on Water, June 13th.

By request of the committee, I furnished them with all the information and figures which I had previously given the Water Board, and I also presented to said Committee a revised estimate of cost, as follows, viz: —

OFFICE OF CITY ENGINEER, CITY HALL,
BOSTON, July 14, 1870.

WALTER E. HAWES, Esq., *Chairman Committee on Water:*

Sir — In the estimate which I submitted to the Cochituate Water Board, dated June 1st, 1870, of the cost of introducing the Cochituate Water to certain sections of Ward 16, I figured the prices of pipe at what was then deemed the current rates. I have recently received actual propositions for doing the work, and beg leave to submit a revised estimate, based upon said propositions,—

ESTIMATE NO. 1 (CAST-IRON).

53,270 feet of 12-inch cast iron pipe, at \$2.90,	.	.	\$154,483 00
46,000 " 6 " " " " 1.65,	.	.	75,900 00
300 Lowry hydrants complete, at \$110.00,	.	.	33,000 00
Gates, etc. . . . .	.	.	10,000 00
Total,			<u>\$273,383 00</u>

ESTIMATE NO. 2 (CEMENT-LINED PIPE).

53,270 ft. of 12-in. wrought iron and cement pipe, at \$2.30	\$122,521 00
46,000 " 6 " " " " " 1.20	55,200 00
300 Lowry hydrants complete, at . . . \$110.00	33,000 00
Gates, etc.	10,000 00
Total,	<u>\$220,721 00</u>

Respectfully submitted,

(Signed)

N. HENRY CRAFTS,
City Engineer.

July 14th, the committee reported in favor of the plan proposed, and recommended the use of the cement-lined pipe; but as the Water Board had full power in the matter, the committee reported an order covering the Engineer's estimate for cast-iron pipe, and recommending a loan of \$275,000 00.

This order was amended so as to provide in addition to the Engineer's schedule the laying of a twenty-four inch pipe from Hampden street to Upham's corner and a twenty-inch main from Upham's corner to the reservoir in South Boston, the entire expense not to exceed \$375,000.00.

The amended order was passed; also an order authorizing the Treasurer to borrow the aforesaid amount.

The orders were passed, and approved by the Mayor July 19th, 1870.

Contracts for the pipe were made as soon as possible, but none were received so that work could begin until the last of September, and since then the delivery has been tardy, and not so much has been accomplished as was anticipated.

The amount of work done under the preceding Order is as follows:—

2,298	feet of 24-inch pipe in	Dorchester
1,287	" 24 " "	Roxbury
4,315	" 20 " "	South Boston
2,993	" 12 " "	Dorchester
2,845	" 6 " "	"

GATES.

1 24-inch gate	3 6-inch gates for blow-offs.
1 20 “	12 Lowry hydrants.
5 12 “	

ENLARGEMENT OF WATER PIPES IN EAST BOSTON.

In August I was directed by the Committee on Water to consider and report what changes should be made in the sizes of the water pipes in East Boston, in order that an efficient supply might be furnished in case of large fires.

At a meeting of the Water Committee there was plenty of evidence adduced by the Chief Engineer of the Fire Department and several Assistant Engineers of the inadequacy of the supply on several occasions. At this meeting I submitted a plan showing the present sizes and location of the pipes in East Boston and of the hydrants also, and stated verbally the changes which I thought should be made. The Superintendent of the Eastern Division, B. W. W., was present, and suggested an additional change in Meridian street. My plan as thus amended was thought to be ample by the Committee and the Engineers, to remedy the difficulty complained of, and I was directed to report my plan in writing, with an estimate of the cost of executing the same.

On the 15th of August I submitted a report and estimate, which may be found accompanying the report of the Water Committee. (City Document No. 79, 1870.)

The amount of my estimate was \$33,369.50. The Committee reported an order requesting the Cochituate Water Board to make the changes estimated for; also an order to borrow \$35,000.00 to cover the expense.

The report and orders were referred to the Cochituate Water Board, who reported, Oct. 20th, 1870 (City Doc. No. 92), recommending a modified plan at a reduced cost of \$20,172.00, — recommending that the expense be charged to the appropriation for the Fire Department.

An order authorizing changes according to the modified plan at an expense not exceeding \$21,000.00, to be charged to the Fire Department, was introduced in Common Council Oct. 20, 1870, and laid on the table.

NEW MAIN WATER PIPE ACROSS CHELSEA CREEK, FROM CHELSEA
TO EAST BOSTON.

The necessity for this work which is now in progress is fully set forth and explained in City Document No. 99, 1870; and as I cannot well state the matter more concisely, I take the liberty of quoting that Document.

CITY OF BOSTON.

CITY HALL, COCHITUATE WATER BOARD OFFICE,

October 27, 1870.

To the City Council:

The Cochituate Water Board most respectfully represent to the City Council that the main pipe now crossing Chelsea Creek to East Boston is broken so as to cause a large waste of water, thereby affecting the supply in that locality; and the Board, after a thorough examination, have unanimously decided that it is inexpedient to attempt to repair it, but recommend that a new pipe be laid according to a plan proposed by the City Engineer in his estimates of Sept. 21 and Oct. 19, 1870, a copy of which is herewith submitted.

As there has been no appropriation made for this purpose, we most respectfully request that the sum of twenty-five thousand dollars be appropriated to pay the expense of laying the same.

Respectfully submitted,

NATHANIEL J. BRADLEE,

President Cochituate Water Board.

CITY OF BOSTON.

IN COMMON COUNCIL, Nov. 3, 1870.

The Joint Standing Committee on Water, to whom was referred the request of the Cochituate Water Board for an appropriation to cover the expense of laying a new main pipe from Chelsea to East Boston, having considered the subject, would respectfully recommend the passage of the accompanying order, providing for the transfer of twenty-five thousand dollars from the reserved fund for that purpose.

The Committee have carefully examined the subject, and recognize the necessity for prompt action, as fully explained in the communication from the City Engineer, hereto annexed.

For the Committee,

WALTER E. HAWES,
Chairman.

Ordered: That the Cochituate Water Board be authorized to lay a new main pipe across the creek between Chelsea and East Boston at an estimated expense of twenty-five thousand dollars, and that the Auditor of Accounts be authorized to transfer said sum for that purpose, from the Reserved Fund.

CITY OF BOSTON.

OFFICE OF CITY ENGINEER, CITY HALL,
NOVEMBER 2, 1870.

WALTER E. HAWES, ESQ.,

Chairman Committee on Water:

DEAR SIR, — In compliance with your request, the following statement relative to the main pipe between Chelsea and East Boston is respectfully submitted:—

In August last a leak was discovered in the 20-inch submerged pipe in the creek between Chelsea and East Boston. The services of M. B. Tower, Esq., and a corps of divers, were immediately secured; and after several days' labor, the leak was found to proceed from a crack in one of the straight flanged pipes immediately under the bolts and close to the flange. The crack was found to be about 18 inches in length, extending partly around the pipe, and the opening was not more than a sixteenth of an inch in width. The water issued in a sharp stream and with great force, manifesting itself by ebullition at the surface. There seemed to be no feasible way of repairing the break without endangering the entire supply for East Boston; and the Water Board, after consultation with the City Engineer and the Superintendent of the Eastern Division, decided to suspend further operations, and directed the City Engineer to furnish estimates of the cost of laying a new 30-inch pipe from Chelsea to East Boston by way of the Meridian street Bridge, or such other route as he might deem expedient. This was on the 31st of August. On the seventh of September the City Engineer submitted a communication with estimates covering the cost of a 30-inch pipe, and also of a 24-inch pipe, by two different routes. The following is a copy of said communication:—

CITY OF BOSTON.

OFFICE OF CITY ENGINEER, CITY HALL,
SEPTEMBER 7, 1870.

N. J. BRADLEE, Esq.,

President of Cochituate Water Board:

DEAR SIR, — In compliance with the vote of your board, the following estimates and suggestions are respectfully submitted:

ESTIMATE FOR A 30-INCH PIPE, VIA MERIDIAN ST. BRIDGE.

3,000 feet 30-inch cast-iron pipe, laid at \$13.50,	\$40,500 00
2 syphons complete and in position	20,000 00
1,124 lineal feet of bridge and housing at \$10.00,	11,240 00
Gates and contingencies	3,260 00
Total	————— \$75,000

ESTIMATE FOR A 30-INCH PIPE, VIA CHELSEA ST. BRIDGE.

8,645 feet of 30-inch pipe, laid at \$13.50,	\$116,707 00
2 syphons complete and in position . . .	15,000 00
400 lineal feet of bridge and housing at \$10.00,	4,000 00
Gates, branches and contingencies . . .	4,293 00
Total	————— \$140,000 00

As I was requested by your vote to estimate the cost of a thirty-inch pipe, I have done so; but I think a brief statement of facts will convince your Board that a twenty-four-inch pipe will be ample for the requirements of East Boston for a great many years. From actual observations, the present average consumption of water in East Boston, is about one million gallons per day. Now suppose the Institutions at Deer Island and Winthrop require 500,000 gallons per day, and that the East Boston requirements are quadrupled, then this pipe will have to deliver 4,500,000 gallons in twenty-four hours. By calculation, I find that a twenty-four-inch pipe will deliver 4,500,000 gallons in twenty-four hours with a loss of head of only three feet.

I should therefore recommend a twenty-four inch pipe instead of a thirty-inch, and submit the following estimates of cost:—

ESTIMATE FOR A 24-INCH PIPE, VIA MERIDIAN STREET BRIDGE.

3,000 feet 24-inch cast-iron pipe, laid at \$9.00,	\$27,000 00
2 syphons complete and in position . . .	20,000 00
1,124 feet bridge and housing . . . at \$10.00,	11,240 00
Gates, branches and contingencies	3,760 00
Total	————— \$62,000 00

ESTIMATE FOR A 24-INCH PIPE VIA CHELSEA STREET BRIDGE.

8,645 feet 24-inch cast-iron pipe laid at \$9.00,	\$77,805 00
2 syphons complete and in position,	15,000 00
400 feet bridge and housing at \$10.00,	4,000 00
Gates, branches and contingencies . . .	3,195 00
Total	————— \$100,000 00

I beg leave to suggest in connection with this matter the advisability of laying a 24-inch pipe alongside of the present 20-inch across the creek. I have seen a drawing of a flexible joint, which I think will be superior to any now in use, and considerably cheaper. I am not yet prepared to submit a definite estimate; but I am quite confident that for \$40,000 a new 24-inch pipe can be laid across the creek, and the

present one repaired. The width of the channel where the present pipe crosses is about 400 feet, and there would have to be that length of flexible pipe. By the Meridian St. Bridge route there would be about 260 feet of pipe within the syphons; and by the Chelsea Street Bridge route there would be about 200 feet in the syphons.

(Signed) N. HENRY CRAFTS,
City Engineer."

At a meeting of the Water Board held on the 7th of September, the above communication was received and laid on the table, and a vote passed directing the engineer to report on the best manner of crossing the creek with a new submerged pipe and an accurate estimate of the cost. On the 21st of September the engineer, after corresponding with the proprietor of the patent flexible jointed pipe known as the "Ward joint," submitted an estimate, of which the following is a copy.

CITY OF BOSTON.

OFFICE OF CITY ENGINEER, CITY HALL,
SEPTEMBER 21, 1870.

N. J. BRADLEE,

President Cochituate Water Board :

DEAR SIR,—The following estimate of the cost of laying a new 24-inch pipe across Chelsea Creek to East Boston is respectfully submitted.

650 feet of flexible jointed pipe at \$24	. . . . .	\$15,600 00
980 " ordinary 24 in. " \$13	. . . . .	12,740 00
4 gates, boxes and setting . . . . .	. . . . .	2,200 00
Dredging and trenching . . . . .	. . . . .	1,600 00
Piling, boxing and fender guard . . . . .	. . . . .	8,820 00
Total . . . . .	. . . . .	<u>\$40,960 00</u>

The price of the flexible pipe as given above is fixed by a definite proposition made by John F. Ward, Esq., of Jersey City.

N. HENRY CRAFTS,
City Engineer.

The City Council having, by an order passed October 4, directed the Committee on Water to examine into the condition of the main pipe leading from Chelsea to East Boston, a subsequent examination was made by the City Engineer, the Superintendent of the eastern division, and a Sub-Committee of the Committee on Water, of that portion of the pipe which is laid upon piling above low-water mark, from the channel on each side, to the adjacent streets. These portions of the pipe were scraped, chiselled and drilled at various points, and in no place was there found to be less than three-fourths of an inch of good iron. It was therefore decided by the Sub-Committee, the Engineer and the Superintendent that it would be inexpedient to duplicate the pipes across the flats; but that the channel section should be relaid and connected with the present mains as shown on the accompanying plan made under your direction.

On the 19th of October, by request of the Committee of the Water Board on the eastern division, I appended to my estimate of September 21st, the following modification:—

“October 19, 1870. By connecting the flexible pipe with the present 20-inch pipe at the edge of the channel instead of in the streets, the foregoing estimate would be reduced to \$25,000 00.

“ (Signed) N. H. C.”

In my judgment, no time should be lost in laying a new submarine pipe as above proposed. When this is done, the repairs upon the broken pipe can be safely made, in the manner shown on the accompanying plan.

N. HENRY CRAFTS,
City Engineer.”

The Order reported as above was passed Nov. 8th, 1870, and the Water Board received propositions from Messrs. Ward and Craven, and from Mr. George H. Norman, for doing the work. The contract was awarded to Mr. Norman, who agreed to lay the new pipe, and repair the old one, for \$24,000.00; the new one to be completed by the 5th of December, and the old one to be repaired with all reasonable despatch, afterwards. The work of laying the new pipe is not yet completed. The trench has been dredged across the bed of the creek an average depth of six feet; the line of pipe is all put together upon skids on the East Boston flats; but the work of sinking the same must

be postponed until the ice clears away. Probably by the middle of February the new line will be in operation.

Since the leak was discovered there has been considerable vague talk about the quantity of water lost, some setting the leakage as high as a million of gallons per day. The Superintendent of the Eastern Division and myself, determined to ascertain exactly what the leakage amounted to, and a plan was devised by Mr. Jones, the Superintendent, by which the leakage was actually measured by meters. The result was that, instead of a million gallons per day, the amount — if the pressure were constantly on the pipe — would be only 192,000 gallons in twenty-four hours, and as the pressure is removed for, probably more than half the time, the actual loss of water cannot exceed 100,000 gallons.

CONSUMPTION OF WATER.

The following is an approximate estimate of the average daily consumption of water by the city, not including East Boston:—

Jan.	12,525,000 gallons	July,	16,392,000 gallons.
Feb.	14,052,000 “	Aug.	17,107,000 “
March,	14,952,000 “	Sept.	16,848,000 “
April,	14,697,000 “	Oct.	16,528,000 “
May,	13,756,000 “	Nov.	14,575,000 “
June,	13,791,000 “	Dec.	14,094,000 “

Average for whole year, 14,943,000.

On the first day of January ¹⁸⁷¹ the consump-

tion was 15,561,000 gallons

On the 14th 14,607,000 “

The total amount of water wasted at the outlet dam during the year, was 4,818,971,000 gallons; equal to an average of 13,202,660 gallons per day, or within less than a million and a half gallons per day of the amount actually used. It would have been

impossible to have saved one-eighth of this amount, even with the dam raised two feet higher; but enough would have been saved to have prevented the serious apprehensions which have been entertained of an inadequate supply. The following statement shows that our recently experienced fears of a short supply had no better foundation than those that were entertained in December, 1864, and previously in January, 1862:—

MONTH AND YEAR.	Average height of water in Lake above the bottom of conduit.	Least height of water in Lake above the bottom of conduit.	Average daily consumption in gallons.	Total rainfall for year in inches.
1862. January	6.09	5.00	17,000,000	46.69
1864. December	5.41	4.83	14,547,000	42.60
1870. December	6.39	5.87	14,094,000	55.89
1871. January 14th . . . . .	..	5.00	..	..

In my report to the Cochituate Water Board in Jan. 1864, after alluding to the remarkably low stage of the water, I used the following language, which may well be repeated at this time, viz: " We should be admonished by the experience of the past year,—when, with a rainfall of $42\frac{6}{10}$ inches, our supply ran so low,—of the danger we should incur, if the rainfall should happen to be as small as in 1822, which was only $27\frac{2}{10}$ inches. The want of adequate storage room has probably been more forcibly exemplified in this year's experience than ever before," etc.

DEER ISLAND SEA-WALL.

IN January, soundings were taken for a sea-wall at Deer Island, extending southwardly from the steamboat wharf, at a point about 240 feet from the shore, a distance of 300 feet, with a return towards the shore of 25 feet. Plans and specifications

were prepared, and in February a contract was made with Messrs. Clapp and Ballou to build the wall for \$29.44 per linear foot.

The water on the line of the wall averaged 3 feet deep at mean low-water, and a trench 13 feet wide was excavated to hard bottom, — about $2\frac{1}{2}$ feet. This trench was filled with large stone, and upon this foundation the wall was built. It was 12 feet wide at the bottom, 4 feet wide at the top, $21\frac{1}{2}$ feet high on an average, with a batter on the front of one in twelve. The tops of the caps were placed at the level of 16 feet above mean low-water. The work was commenced April 5, and finished in October. The amount of the final estimate was \$9,568.00. August 18, a further contract was made with the same parties to build so much of a return wall, from the end of the wall already built to the shore, as could be laid from the stone sloops, — the wall to be of the same general character as that already laid, except that no dredging was required and the dimensions of the wall diminished as it approached the shore.

The work under this second contract was finished about the 1st of November, at a cost, including \$32.00 paid for hauling stone, of \$2,305.00, making the total cost of the wall \$11,873.00. The appropriation for this work was \$12,000.00; unexpended balance \$127.00. Henry Manley, Esq., had charge of this work.

ATLANTIC AVENUE SEA-WALL.

This work was alluded to in my last report as so nearly completed, that by May 1st we might expect to see it finished. By the terms of the contract, the contractors were to set an edge-stone, and pave the sidewalk with brick. But as the contractor for filling the street in rear of the wall, was by the terms of his contract obliged to use the sidewalk to run his cars over, it was decided to release the former from his obligations to complete the sidewalks at the time appointed, and to pay him for the balance of the work, withholding a sum ample to complete the entire work.

The final estimate was made May 1st, covering the entire work and withholding the amount necessary to finish the sidewalks.

Mr. Manley, the assistant in charge of this work, has by my directions kept up a series of observations during the entire season, to determine the effect of the filling in the rear, upon the stability of the wall.

The figures show a very slight movement, except in one place, where the dredging was omitted and the mud was deeper than usual. The rate of movement is rapidly decreasing, and the deposit of additional stone ballast in front of this piece of wall, will, I think, render it secure against further movement.

ATLANTIC AVENUE FILLING.

The work under the contract for filling this avenue with material from Fort Hill, commenced October 27th, 1869. The contractor, B. N. Farren, Esq., completed the entire work October 12th, 1870.

The final estimate of the amount of earth removed was 82,850 cubic yards, at seventy-five cents, \$62,137.50. Monthly estimates were made of the amount removed, and the work of supervision of the filling of the avenue was performed by my assistant, W. F. McConnell, Esq.

BROADWAY EXTENSION.

Assistant McConnell has, from the commencement of this work, had charge of all the engineering field work. During the early part of the year this work required a very considerable share of his time and attention; but as the work has progressed, the requirements have diminished, and at the present time the work is so near completion, that very little attention from this department is required.

The abutments and retaining walls were completed about the first of March by the contractors, Messrs. Clapp and Ballou. The final estimate amounted to \$65,304.74.

Great care was taken in the matter of lines and grades upon the iron portion of the structure, in order that all the parts should come together well, and I am happy to say, that, with the valuable assistance and co-operation of the local superintendent, Mr. Dexter Pratt, in this matter, the structures have been admirably fitted to the lines and grades.

In my last annual report I gave a full and minute description of this structure, and its condition at the beginning of the year. It was my intention to have given a description of operations during the past year, and a statement of the present condition of the work; but I find this labor all saved to me and most admirably done by the superintending engineer, Mr. T. Willis Pratt, in a report made to the Committee on Paving, dated December 27th, 1870 (City Doc. No. 120, 1870). As this report is in the nature of a sequel to the description of the work and its condition, as given in my last year's report, I take the liberty of inserting it in this place.

REPORT.

CITY HALL, BOSTON, Dec. 27th, 1870.

GEORGE O. CARPENTER, Esq., *Chairman of Committee on Paving.*

SIR: In compliance with your request, and also the usual custom at the close of the year, I have the pleasure of making the following report upon the cost, present condition, and time of completion of the iron bridge now building for the extension of Broadway across Fort Point Channel.

At the time of the surrender of the contract by the Mosely Company in September, 1870, there had been paid to said Company the sum of \$314,480. According to the terms of the contract, payments were to be made on the 1st and 15th of each month, for work done and materials furnished. The committee of 1869 authorized the placing of extra flanches upon all the large screw piles, on the recommendation of the City Engineer and the consulting Engineers, Gen. J. G. Foster for the Harbor Commissioners, and myself. This was done by the Mosely Company, and the payment of the cost, \$9,116.56, is included in the above amount, having been paid with the estimates as provided in the contract. Deducting this amount from the gross amount paid

at the time of the surrender, and we have \$305,373.44 as the amount paid on account of the contract to September 15th, 1870. The value of the contract was \$331,708.76, therefore the balance to complete the work when the Mosely Company failed was \$26,335.32.

Since that time we have expended for labor and materials, as per approved pay-rolls and bills, to and including December 15th, 1870, the sum of \$15,499.34; leaving a balance of \$10,835.93 to complete the structure. The bill for extra work by the Mosely Company contains two other items for oak piles and guard timber amounting to \$1,547, which have not yet been admitted as correct, though not absolutely rejected. I feel almost certain that we can finish the whole within the amount authorized to be paid. Of the present condition of the work I have to say: The whole extension, from Federal street to Albany street, we may consider under five divisions. *First*, between Federal and Foundry streets and between Lehigh and Albany streets, the road-bed has solid earth filling protected by heavy abutments and bank walls of good masonry. All the masonry is finished; and the roadway is completely graded and paved from Federal street to Foundry street. From Lehigh to Albany street the roadway is not up to grade, though a little gravel dressing would make it passable.

Second Division: Consists of the small bridges of fifty or more feet span, over Lehigh street and Foundry street, which are substantially complete and have received the pavement.

Third Division: Consists of the portion supported on iron columns and small screw piles, four hundred and forty feet between Foundry street and Old Colony railroad, and two hundred feet from Lehigh street into the dock below the Boston & Albany railroad tracks. These portions are substantially complete, and have received the pavement and sidewalk; some fencing is still unfinished, and as yet no braces have been put in between the columns.

Fourth Division: Consists of the two arched spans of one hundred feet each. These are all in place, with the floor beams all in, and planking laid almost complete. There is still the fences to put on, and the ends which match with the draw are to be formed after the draw can be turned round. Bracing of the supporting columns under the arches is also to be done after the draw is turned and adjusted to the line of the roadway.

Fifth Division: Consists of the drawbridge and centre pier, with its adjunct the fender pier. The centre pier, consisting of nineteen columns or screw piles of cast-iron, one and one-fourth inch thick, and two feet internal diameter, filled with concrete, and properly connected

and braced, is complete. The fender pier is also completed. Of the drawbridge, the arches, tower, and suspending rods are in place, and three-fourths of the flooring is complete. The draw is standing in its open position over the fender pier and is supported on staging. When the flooring is in and completely secured, the draw can be turned experimentally, so that the bearings and ends of the draw, and large arch spans can be fitted to each other, and the machinery and supports tested to their utmost capacity. This part of the work must necessarily be nicely and carefully done, and more so at this season of the year when the low temperature prevailing contracts the material used to the smallest dimensions, and at the same time makes the employees very uncomfortable by exposure and contact with the iron.

The specifications require two hot-air engines of three horse-power each. I have not as yet engaged any, but have temporarily connected one of the hoisting steam-engines (used for pile driving) to experiment with. We have the offer of a hot-air engine on trial for a time, but the trial of the steamers first will determine the power required to move the draw, after which the other can be introduced and permanently adjusted, in the house in the centre pier. With comfortable working weather I think we can put in the braces named above, adjust the ends of the draw, fit up the bearings, set up the fences, gates, etc., etc., during the following month of January, 1871, so that early in February the bridge may be opened for travel. Owing to the very confident proposition of the contractor in the first instance, to finish this work on the first of December, 1869, the impression on the public mind was that it was a work of not much magnitude, for which a high price was to be paid. In reality, it is the greatest iron bridge ever undertaken in New England, embracing some of the most intricate engineering operations, requiring great care and prudence in conducting the preparations, and constant watchfulness at all times. I am pleased to state that thus far no accident has occurred to the injury of any individual on any part of this work. We have over eleven hundred feet in length of iron work which is sixty feet in width. The draw necessitates that the structure be made in three separate parts, and the contingency arises, how to manage the contraction and expansion of the material, so that the draw shall not be bound tight in the summer, under a high state of expansion, or left too loose in winter when the material is most contracted. The mode proposed by the engineer of the contracting parties, your superintendent considered did not meet the case, and another plan was proposed; considerable discussion ensued; but it was not thought advisable at

that time (late in the year of 1869) to hastily decide a question which might possibly be left until the final completion of the super-structure. However, the foundations for the proposed remedy, consisting of piles, were authorized by the committee of 1869; the piles were driven and the bills paid. The committee of 1870 have not authorized any extra expenditures, and none have been asked for during their term. It is unfortunate that we are to complete this work during the cold season, on account of the difficulty of calculating for the effect of expansion when the hot weather comes on. We can put the draws in workable condition, and leave the remedy to be applied during the warm season, when the real effects and necessities more plainly show themselves.

In conclusion I desire to say, that thanks are due to Mr. Dexter Pratt and the employees under him, for the faithfulness with which they have performed all their duties, both when under the Mosely management and also when transferred to the care of the city, under the Committee on Paving. I also desire to thank your Committee for the confidence reposed in myself, from the first of this year, and in having intrusted me with full power to complete the work under the contract or otherwise.

Respectfully submitted by

T. WILLIS PRATT,

Superintending Engineer Broadway Bridge.

Although not personally responsible for the superintendence of the construction of this work, yet — as the contract requires that the city engineer shall be one of the parties to whose satisfaction the work shall be done — I have felt it to be my duty to inspect the work from time to time, and have had occasion to consult and advise frequently with both the superintending engineer and the local superintendent, and I desire to say that, in my judgment, more reliable and efficient agents in a work of this character and magnitude, and in their respective spheres, it would be difficult to find. If the work intrusted to their care is not well done and a success, it will be no fault of theirs.

At the date of this writing (January 15th) I find the work in such condition that it is safe to predict its entire completion, except the permanent grading between Lehigh and Albany

streets, by the first of March. This latter section may be temporarily graded so as to be passable, until such time as it may be decided whether Broadway is to be extended directly to Washington street, at its junction with Pleasant street, or via Way and Castle streets, to Washington street and thence to Tremont street.

FORT HILL.

After the grading of Oliver street, which was completed in August 1869, the work on the main body of the hill was commenced on the easterly side at the level of Purchase street, under a contract for filling Atlantic avenue, made with B. N. Farren, on the 27th of October, 1869. As before stated under the head of "*Atlantic avenue filling*," this work was completed October 12th, 1870.

March 1, 1870, Timothy Hannon began to remove earth from the hill — excavating by hand labor, under a contract to fill the docks west of Atlantic avenue and between Central and Long wharves. This filling was completed May 10th, 1870. The final estimate as certified by the City Engineer amounted to 8,122 cubic yards at sixty cents, \$4,873.20.

July 1, 1870, Mr. John Souther began to remove earth from the hill under a contract to fill the dock west of Atlantic avenue and between India and Central wharves. He used a steam excavator and completed his work December 31st, 1870.

The final estimate, as certified by the City Engineer, amounted to 46,800 cubic yards at fifty-five cents, \$25,740.00.

About the middle of October, B. N. Farren and Martin Hayes began to remove earth from the hill, each under an independent contract to fill the docks west of Atlantic avenue and between Long and Commercial wharves,— Mr. Farren using a steam excavator, and Mr. Hayes working by hand. Monthly estimates are made by Mr. McConnell, assistant in charge, from measurement in the bank of all the material thus far removed, and said estimates certified by the City Engineer.

Nov. 21, 1870, John Souther began to remove earth from the hill under a contract for filling in the Suffolk-street District.

This work was started by hand, but since the completion of Mr. Souther's contract for filling the dock, before referred to, the steam excavator used on that work has been transferred to this.

Under the several contracts above referred to, that portion of the hill east of Oliver street and above the level of Purchase has been entirely removed; the section bounded by Oliver street, Milk street, Broad street and Washington square has been cut down to the established grade. So also has the section west of Oliver street, between Milk street and Pearl place.

Mr. Farren is now working on the east side of Oliver street and Mr. Souther on east side of Oliver street from it towards Broad street. Mr. Hayes is taking off the top of the hill on the west side of Oliver street. These three contracts are being vigorously prosecuted, and at the present time there is double the amount removed monthly that has been heretofore since the commencement of the work in 1866.

Messrs Farren's and Hayes's contracts are to be completed May 1, 1871. The time of completing Mr. Souther's contract depends upon the operations on the Suffolk-street district; but the amount he is to remove is not to exceed 80,000 cubic yards.

The amounts of earth removed under these three contracts to Dec. 20, 1870, the time of taking the measurements for monthly estimates, are as follows:—

By B. N. Farren	17,000	cub. yards
Martin Hayes	22,800	“ “
John Souther	3,000	“ “

The contract price of Mr. Souther's work is \$9.60 per square, or \$1.20 per cubic yard.

A contract has been made with Albert Boschke to remove all the earth that will be left after the completion of existing contracts. He is to begin work Feb. 1, 1871, and to remove

1000 squares per month until finished, and to receive \$2.50 per square. The material is to be used in filling flats on the northerly shore of South Boston, belonging to riparian owners.

BERKELEY AND PROVIDENCE STREET RETAINING WALLS.

Plans and specifications were prepared for this work early in the year; proposals were invited and the contract awarded to N. C. Munson, Esq. Mr. Munson sub-let the work to Messrs. Blake and Parker, who began the work June 1.

The wall is of granite, of the style of work known as "rubble masonry," and laid in cement mortar. It is capped flush with the sidewalk with a 12" \times 12" granite cap.

By the original plan and contract the entire wall — beginning at the northerly abutment of the Berkeley-street bridge, and extending along the easterly side of said street to Providence street, thence by the southerly side of Providence street about 685 feet — was to rest upon piles; but upon further examination they were considered unnecessary for the lighter portion of the wall on Providence street. It was accordingly decided to leave them out of that part of the wall, and to put the bottom of the wall at grade 7.00 above mean low-water, or four feet below the B. & P. R. R. grounds. The piles under the Berkeley-street wall were cut off at grade 5.00.

The contract was amended July 6, 1870, to provide for this change, and, in consideration thereof, the city paid the contractor \$450.00. This allowance was made because the contractor had made provision for doing all the work, and the abandonment of this portion of the contract would otherwise have been at a loss to him.

By request of the Boston & Providence Railroad Co. the Providence-street wall was terminated at a point one hundred and fifty feet west of the point fixed by the original plan and contract. The contract was again amended August 9th, 1870, and the contractor allowed for the change \$250.00.

The entire wall was completed about the first of September, and the final estimate as certified by the City Engineer was as follows:—

2,820 cu. yds. excavation at 40c.	. . .	\$1,128 00
239 Piles at \$3	. . .	717 00
1,400 cu. yds. rubble masonry at \$6.70	. . .	9,380 00
704 lineal feet of coping at 40c.	. . .	281 60
		<hr/>
		\$11,506 60
Consideration for amendment to contract July 6,		
1870	. . .	450 00
Consideration for amendment to contract Aug. 9,		
1870	. . .	250 00
		<hr/>
		\$12,206 60

The grading of the streets behind the wall was done by Martin Hayes. The final estimate of same was made Sept. 20th, 1870. Assistant McConnell had charge of the field-work and estimates on this work.

SUFFOLK-STREET DISTRICT.

In January, test-pits were sunk to ascertain if the character of the soil would be suitable as a foundation for the abutments of the proposed bridge in extension of Shawmut avenue over the Boston and Albany Railroad. Additional pits were sunk in October on the site of the northerly abutment, and by the courtesy of Mr. Firth of the Boston and Albany Railroad, the use of the northerly track of said road was granted for that purpose.

Levels have been taken to determine the exact height of the Boston and Albany Railroad tracks and the clear headway at the several bridges.

In November and December a large gravel bank at Needham

was surveyed, the same to be used for filling the Suffolk-street District. The contractors for filling this district, Messrs. Manuel & Haynes, have not, as yet, begun operations at this bank; but are purchasing gravel of the Boston and Albany Railroad Co., from their bank at Newton.

Measurements and examinations of the cars used for hauling the gravel to the District, have been made for purposes of estimating the quantities delivered.

By direction of the Committee on the Suffolk-street District, plans were prepared early in the year for two abutments, a central pier, and an iron bridge for the extension of Shawmut avenue over Orange street, and the tracks of the Boston and Albany Railroad. The plan, as then contemplated, was to leave Orange street at its present grade, as an avenue of access to the grounds of the railroad company; to place the southerly abutment on the south side of Orange street, a central pier about on a line with the southerly abutment of the Washington-street bridge, and the northerly abutment on the site of the present retaining wall on Indiana place. These abutments and pier to rest on pile foundations.

Subsequent examinations, above referred to, proved that a good foundation could be obtained by excavating to about the level of mean low-water; so the plans were modified to dispense with piling. The plan first drawn for the superstructure contemplated a system of wrought-iron girders placed four feet apart under the roadway and five feet apart under the sidewalks, to be built continuous over the central pier and to have a depth of three feet at the centre of the spans and two feet six inches at the abutments. These girders were to be tied together at top and bottom, and X bridged at intervals with angle iron.

The whole distance from abutment to abutment is about 113 feet, and the width of the roadway 60 feet. By the plan proposed there are no main girders or trusses projecting above the level of the roadway as in most of the bridges, and the roadway is entirely clear of obstructions.

In August I submitted an estimate of the cost of the abutments, pier and bridge according to my original plan to the Chairman of the Committee on Streets.

The masonry was estimated	\$18,447 00
The superstructure	30,240 00
	<hr/>
	\$48,687 00
Or, in round numbers	\$50,000 00

By direction of the Committee on the Suffolk-street District the plans were re-drawn so as to cover only one span, — that from Indiana place over the railroad, — as there seemed to be a probability that Orange street would be raised, and, in that case, the space between the central pier and the southerly abutment would be filled solid. The plans were to be so arranged, however, that the second span could be added if negotiation with the railroad company for the raising of Orange street should fail. New plans and specifications were accordingly prepared in October; and, Nov. 3d, proposals for the stone work were advertised for. The contract for this portion of the work was made with Mr. Charles W. Parker, of Rockport, on the 26th of November; the work to be completed on or before May 1, 1871.

Dec. 7, proposals for the superstructure were invited, and bids received ranging from \$13,900.00 to \$22,286.41.

The contract was awarded to G. W. and F. Smith, they being the lowest bidders, and the agreement executed Dec. 30, 1870.

The contractors are to commence putting on the structure by the 1st of May, or as soon as the abutments are ready, and to complete the work within thirty days.

BRIDGES.

The following is a list of the Bridges which the City has to maintain in whole or in part:—

1st. BRIDGES OVER TIDE-WATERS, RIVERS AND CREEKS.

- * Albany street bridge, over the Roxbury Canal.
- * Dover street “ across entrance to South Bay.
- * Broadway “ over Fort Point Channel (now building).
- * Federal street “ “ “ “
- * Mt. Washington Av. bridge, over Fort Point Channel.
- * Meridian street “ over Chelsea Creek.
- * Chelsea street “ “ “ “
- * Neponset “ “ Neponset river to Quincy.
- * Granite “ “ “ “ to Milton.
- Winthrop “ from Breed’s Island to Winthrop.
- * Commercial street, “ over Creek at Com’l st. Dorches’r.
- Milton, “ “ Neponset river at Lower Mills.
- Mattapan, “ “ “ “ Upper Mills.
- Mill Dam, “ over Sluices connecting the “ Full Basin ” with Charles River.
- Longwood Avenue bridge, over Longwood Creek and the Brookline Branch Railroad.

2d. BRIDGES OVER RAILROADS AND HIGHWAYS.

- Albany st. bridge, over Boston and Albany Railroad.
- Tremont st. “ (water pipes) over “ “ “ “
- Shawmut av. “ (now b’ld’g) over “ “ “ “
- Ferdinand st. bridge, over Boston and Albany Railroad.
- Berkeley st. “ “ “ “ “ “
- Columbus av. “ “ “ “ “ “
- Dartmouth st. “ “ “ “ “ “
- Berkeley st. “ “ Boston and Prov. Railroad.
- Dorchester st. “ “ Old Colony and Newport “
- Broadway “ “ Lehigh and Foundry streets.

* Bridges provided with draws, or opening for the passage of vessels.

All the bridges marked with an asterisk in the first list and the Winthrop bridge are, or will be, when completed, in the charge of Superintendents, under the direction of the Committee on Bridges.

All the others except the water-pipe bridge at Tremont street are in the charge of the Superintendent of Streets, under the direction of the Committee on Paving.

ALBANY-STREET BRIDGE (OVER ROXBURY CANAL).

There is no official superintendent of this bridge; but Mr. F. Winchester is employed by the Committee on Bridges, and by the Committee on Harbor, receiving \$300 per annum from the former, and \$200 from the latter.

There has been expended in repairs on this bridge, \$1,164.86.

DOVER-STREET BRIDGE.

No radical repairs have been made on the draw of this bridge as I recommended in my last report; but considerable work has been done to keep the draw in a movable condition. The piers have been extended southwardly, replanked, and oak ribbons or girders fitted to the sides. The cost of this work, including stock and labor, was \$2,077.50. The ordinary repairs for the year amounted to \$1,729.80.

FEDERAL-STREET BRIDGE.

I have nothing to add to the statements made in my last report relative to this structure, except, perhaps, that subsequent reflection has confirmed the opinions there expressed "that the expense of permanent foundations and an iron superstructure as an adjunct of the present patched-up bridge and at its present grade would be quite unwarrantable." I am strongly inclined to the opinion that an iron structure resting upon screw-piles, placed in piers or rows forty to fifty feet apart, and at a grade sufficiently high to place the running gear and machinery

above the reach of tide-water and ice, will be found cheaper in the end than any attempt to widen the bridge and draw, in its present condition. A plan has been prepared, showing a proposed arrangement of a screw-pile pier; but no estimates of cost have yet been prepared.

The cost of repairs on this bridge during the past year was \$3,641.39.

MERIDIAN-STREET BRIDGE.

It was found necessary to make quite extensive repairs of the drawbridge, involving the stoppage of the travel for several days. The wheels were all removed and their running faces turned down true. A new wrought-iron band was attached to the axle-rods on the side of the wheel next the centre pivot, and braced to the former band on the outer side of the wheels. The tracks were levelled, and heavier wrought-iron plates interposed between the track plates and the oak plank beds.

These changes made the draw move easier for awhile; but the superintendent complains that it still runs very hard.

The cost of the repairs on this bridge during the year amounted to \$2,091.76.

The draw will have to be replanked, the concrete sidewalk repaired, and some of the loose plates under the tracks secured by stouter lag screws. A portion of the draw pier also needs replanking.

CHELSEA-STREET BRIDGE.

Very little has been required or done on this bridge during the year; the repairs amounting to only \$43.56. The draw-bridge and the planked portions of the approaches will have to be replanked or partially so this season.

WINTHROP BRIDGE (BREED'S ISLAND TO WINTHROP).

An examination of this structure was made early in the year, and the concealed defects alluded to in my last report were

made quite apparent. By direction of the Committee on Bridges, I prepared a plan of proposed repairs, and specifications and schedule; but it was extremely difficult to prescribe the amount of old material that should be replaced with new without having the bridge entirely stripped. I proposed to the Committee that, in view of the uncertainty of the amount of stock and labor required, it would be good policy to purchase the stock and employ day labor; but it was decided to let the work by contract. Accordingly —

Proposals were invited on Specifications calling for a definite amount of new stock and the labor required to substitute it for the old.

The contract was awarded to Salma E. Gould, of East Boston, for \$3,130 00

There was a subsequent agreement to pay for	
removal of earth covering	500 00
For keeping the bridge open during repairs	100 00
	<hr/>
	\$3,730 00

The removal of the earth covering, which was about twenty inches deep, showed the flooring almost entirely rotted away, as I expected; but the removal of the planking exposed a much worse state of affairs among the stringers. By direction of the Committee, Mr. Gould removed all the stringers which I condemned, and an exact schedule of all extra stock ordered, was kept.

The bill for extra stock and labor amounted to \$1,990.44, making a total of \$5,720.44 paid to Mr. Gould. Other payments made the total cost of rebuilding . . . \$5,824.44.

NEPONSET BRIDGE (OVER NEPONSET RIVER).

An examination of this structure was made in company with the Committee, in February, and I reported to the Committee in writing as follows:—

This bridge is about thirty feet wide, and, including the draw, about one hundred and fifty-three feet long from the northerly abutment to the Quincy line. The opening for vessels is about thirty feet. The bays are irregular in width, from fourteen to twenty feet. The piles are about seven and a half feet apart, and are very poor. The caps and planking are in fair condition. The abutment and the bulkhead on the westerly side are in an unfit condition to hold the filling of the street: both have given way, and been patched up in a very bungling manner. The draw is sound, but very lightly built. The piers are in a wretched condition: the side-planking is almost entirely gone, and the piles so poor that they would hardly hold a new planking. The piers are too short by fifty feet. The filling in of the abutment has crowded the bridge so that the piles all lean towards the draw.

The structure as a whole is in such condition that it would be poor economy to spend anything on repairs, and I should recommend rebuilding the whole structure, abutments, bridge and piers at the earliest moment, as a measure of safety and economy.

The draw opening should be thirty-five feet in the clear. The draw should be a pivot counterbalanced draw. The bridge and approaches should be made, at least, fifty feet wide. The piers should be about one hundred and fifty feet long and twenty feet wide. There should also be about one hundred and twenty feet, lineal, of fender-guard.

The expense of rebuilding as above thoroughly, would be approximately, as follows, viz:

(Plan No. 1.)

Abutment	\$1,558 00
6000 sq. feet of piers . @\$1.00,	6,000 00
4,500 " " " drawbridge @ 2.50,	11,250 00
3150 " " " bridge @ 1.50,	4,725 00
120 lineal feet fender-guard, @ 10	1,200 00
Planking sides of piers . . .	800 00
	<hr/>
	\$25,533 00
	<hr/>

(Plan No. 2 — repairs.)

The least that can be done, without throwing money away, would be to drive new oak piles along the entire front of the piers and replank the sides; rebuild the abutment and retaining wall, and build one hundred and twenty feet of fender-guard.

The cost of these items would be about, . \$7,500 00

(Plan No. 3 — repairs.)

Another way to improve without an entire renewal — leaving the present draw as it is, — would be to rebuild the abutment and retaining wall. . . . \$1,558 00

Rebuild and replank sides of pier 6,800 00

Rebuild 70 feet in length of the bridge, 50 feet wide 5,250 00

Build 120 feet fender guard 1,200 00

14,808 00

This structure should be examined by the committee, and some action taken this year. The repairs have cost \$353 52

GRANITE BRIDGE (OVER NEPONSET RIVER).

The repairs on this bridge have been very light, amounting to only \$60.82

MILTON BRIDGE (OVER NEPONSET RIVER AT LOWER FALLS).

In my last report I suggested that a widening of this structure would be an improvement. During the summer I was called upon to furnish an approximate estimate of the cost of widening the bridge to a width of fifty feet by the Committees of Paving and Streets. A rough estimate was then made for extending the piers and arches and for building a retaining wall: the cost of the whole I figured at \$10,500 00. As some objections were subsequently made to obstructing the waterways by extending the stone piers, I proposed to the Committee a structure of iron that would obviate the objections raised. Plans are now in progress for this work.

MATTAPAN BRIDGE (OVER NEPONSET RIVER).

This bridge has required no repairs during the past year, and will need but little the present — say a partial replanking, and repainting the iron-work, which is full light, and should not be allowed to waste by rust.

COMMERCIAL STREET BRIDGE (OVER CREEK AT COMMERCIAL POINT).

In reference to the condition of this structure, I reported to the Committee on Bridges, Feb. 19, 1870, as follows, viz: —

“The total length of this bridge, including the draw, is about two hundred and twenty-seven feet. The draw is located about forty-six feet from the northerly abutment, and the opening is twenty-six feet wide.

“The width of the bridge on the northerly side of the draw is forty-seven feet at the abutment and thirty-six feet at the draw. The width south of the draw is about thirty-three feet. The draw is light but sound, and the caps and planking on the portion north of the draw are in passable condition; and that is about all there is of the whole structure that is good for anything. The piles are all spruce and there are hardly any fit to remain. The entire southerly portion of the structure is not safe.

“There seems to be no good reason for maintaining a bridge of any kind at this place; but it would undoubtedly be imprudent for the city to attempt to fill up the creek by solid filling at this time. The expense would be very great for the enclosing walls, filling and damages, which would undoubtedly be claimed by the shore owners on the creek.

“The cost of enclosing walls and solid filling would be about \$20,000.00; of earth filling without walls, about \$12,000.00.

“A new structure (exclusive of the draw), built with oak piles, would cost about \$8,000.00; if built with spruce piles, \$5,000.00.

“I should recommend rebuilding with spruce piles according to the last plan, which I think will last, with slight repairs, until the basin and creek are filled.”

MILL-DAM BRIDGE (OVER SLUICES).

In my last report I stated that "plans had been prepared for covering these sluices in a safer and more substantial manner, with either a wooden or iron structure, whichever shall be decided most suitable under the circumstances."

By direction of the Committee on Paving, specifications were drawn for the wooden structure,—proposals invited, and the contract awarded to Boynton Brothers for \$8,400.00. Extra work was done to the amount of \$421.60, making the total cost \$8,821.60.

During the progress of the work, the foundations of the gate-house, on the southerly side of the mill-dam covering the gates, became undermined, the building and gates fell over into the basin, thus leaving the ends of the piers exposed to the danger of further undermining. In fact one or two had already settled. Soundings were taken which showed that the tremendous force of the tide rushing through these contracted openings had excavated a pit twenty feet in depth above the sluices, and had already eaten its way for some distance beneath the apron of the sluices. Vigorous measures were at once taken by the superintendent of streets, and the space already excavated was filled with stone to the level of the apron or floor of the sluice-ways.

LONGWOOD AVENUE BRIDGE.

In my last report, I stated that surveys, levels and plans were in progress for a new structure. The plans, as prepared, contemplated an abandonment of the present wooden trestle-work; changing the bed of the present creek so as to conduct its waters through a masonry culvert twenty feet in width; said culvert to be placed parallel with the railroad and in the rear of the easterly abutment of the bridge over said railroad. The culvert and abutment being built and the necessary wing-walls, the entire roadway east of the easterly abutment was to be filled

solid, and the portion over the railway to be spanned by an iron bridge similar in construction to that previously described as being built over the Boston and Albany Railroad on the extension of Shawmut avenue.

Estimates were made and submitted to the Committee on Paving; but the reduction of the appropriation, asked for by the Committee, prevented immediate action. The bridge was subsequently reported unsafe by the Police, and I was called upon to report, if possible, a mode of temporary repair which should make the bridge safe for a few years. A plan was proposed and endorsed by E. S. Philbrick, consulting engineer for the town of Brookline. The work was done in accordance with said plan by Joseph Ross, Esq.

The total cost was \$3,480.83, of which the town of Brookline paid about one-half.

MT. WASHINGTON AVENUE BRIDGE.

The necessity of making very thorough repairs upon this bridge was urged by me in my last annual report, and after a thorough examination of the structure by the committee, the necessity was fully recognized, and I was directed to prepare plans and specifications, which I did, and submitted the same with a preliminary estimate of the cost to the committee. No formal vote was passed by the committee approving the plans; but they were deemed generally satisfactory, and I was directed to lay them before the Harbor Commissioners for approval. The Commissioners passed only upon the plan of piling proposed, and that was approved.

I proposed for the drawbridge an entire new structure above the foundations, of substantially the same dimensions as the present one as to length and width. The trusses were to be of wood and iron like the present one, except that they were to be of the style known as the "Pratt truss." My reason for proposing wooden trusses was, that I presumed the bridge

would be considerably lighter, and also less expensive. Subsequent investigations, however, satisfied me that, for structures of equal strength, the difference in weight between wood and iron is less than I had supposed, and, in view of the increased durability of iron over wood, it would be better to incur the additional first cost.

The estimates, however, had been submitted to the Committee on Bridges for doing the work according to my original plan for the sum of \$60,000.00, and an order introduced in the Board of Aldermen, authorizing the committee to make the repairs, etc., at an expense not exceeding my estimate, and authorizing the Treasurer to borrow the sum of \$60,000.

When these orders reached the Council, the following proviso was appended: —

“Provided, that no portion of this money shall be expended until the Committee on Bridges shall have advertised for *plans* and proposals for rebuilding said bridge, and a contract made with responsible parties to complete the entire structure for \$60,000.00, or less, *upon a plan satisfactory to the City Engineer.*” This proviso was attached in Common Council, May 26, and passed by a vote of 49 yeas, to 1 nay. In Board of Aldermen, May 30, the order, as amended, was concurred in by a unanimous vote.

At a meeting of the Committee held soon after the passage of the foregoing orders, the following notice submitted by the City Engineer, was approved by the Committee, the same to be publicly advertised: —

CITY OF BOSTON.

NOTICE TO BRIDGE BUILDERS.

Plans, specifications and sealed proposals will be received at the office of the City Engineer, until Thursday, June 30th, at 12 o'clock, M., for making all necessary alterations and re-con-

struction on the Mount Washington Avenue Bridge, draw, draw-pier and abutments. The right is reserved to reject any or all plans and proposals.

By order of the Committee on Bridges.

WALTER E. HAWES, *Chairman.*"

At the same meeting the Engineer desired instructions from the Committee as to what disposition should be made of the plans already prepared by him. Should they be withheld from public inspection, and parties desiring to submit plans of their own, be told to go and examine the bridge for themselves, and get their own information as best they could, and make their own suggestions; or, should I offer free access for all who desired to examine the plans already made, and inform them that they were free to bid upon the plans as they were, or to submit any new plan or modification of the old one, and bid upon those?

It was unanimously agreed by the Committee and myself, that the plans already made, and all information in the possession of the Engineer should be placed at the disposal of all parties, and that parties applying be informed that it was the desire of the committee that the bridge in its present condition should be examined, and that full liberty was accorded to make any changes or modifications in the style of drawbridge, or methods of repairs suggested by the Engineer, it being the wish of the Committee to secure the best plan for doing the entire work within the limits prescribed by the order.

I stated to the Committee that I would afford every facility in my power to parties desiring to bid or submit plans, and that I was not so tenacious of my own plan or so conceited in reference to my own ability in the matter as to preclude an impartial judgment upon the plans of others.

The advertisement for plans, specifications and proposals was inserted in the papers June 14, and parties given until the 30th

to prepare plans and specifications. The time was afterwards extended to the 6th of July, and during this interval every facility in my power was impartially given to all parties who desired information as to what I deemed requisite to put the bridge in first-class order, preserving what was already good.

On the sixth of July the proposals were opened by the committee at the office of the City Engineer.

There were nine propositions received from seven different parties, one party making three separate propositions. There were five different plans of drawbridges submitted, besides the original one prepared by the Engineer. In every case but one the City Engineer's plan for repairs of the approaches to the draw were used and estimated upon by the parties submitting proposals. At this meeting the plans were partially examined and discussed, a schedule of the proposals made, and the specifications and proposals filed and indorsed. The committee adjourned to meet on the following Monday, the eleventh, it being understood that the Chairman and Engineer should, in the mean time, visit New York and vicinity to examine iron drawbridges and the methods of operating, and also to afford the Engineer an opportunity of critically examining the several plans submitted. The visit was made and we came home fully decided to discard the original plan of a wooden truss and to confine the selection to those plans of iron that came within the limits of \$60,000, prescribed by the order.

On Monday the Committee met at the office of the clerk of Committees. The City Solicitor was present at the opening of the meeting; the chairman, the clerk of Committees and the City Engineer were present during the entire session, and the other members of the Committee were present most of the time. The City Solicitor's opinion was asked in reference to the powers of the Committee under the order, and the proper course to pursue. His reply was, in substance that the order conferred no power upon the Committee to make a contract, and that, having

advertised for and received plans and proposals, it was the duty of the City Engineer to indicate which plan he preferred, and then, if the committee coincided, to report to the Board or Aldermen, an order authorizing a contract to be made for the execution of such plan.

There were two propositions covering the original wooden trussed drawbridge of the City Engineer and his plans for the remainder of the work, and one for a "Howe truss" wooden drawbridge, and the Engineer's plan for the rest of the work.

These three were set aside, as the Engineer expressed his preference for the plans of iron trusses or girders. Two of the plans and propositions, covering the cost of very substantial iron drawbridges combined with the Engineer's plan for the rest of the work were also set aside as the proposals exceeded the sum of \$60,000.

One proposition was set aside as not conforming to the requirements of the advertisement, covering only a portion of the work. And another proposition was not deemed admissible, as it was a bid made by one party upon plans submitted by another.

The plans and propositions were now reduced to two, one covering the cost of a drawbridge with iron cords and ties, and wooden diagonal bracing, combined with the Engineer's plan for the balance of the work. The other was for a drawbridge with plate iron girders, combined with a modification of the engineer's plan for the rest of the work. Of the two plans I decidedly preferred the latter, the girders being entirely of iron, and it was, in fact, simply a modification of my original plan, with iron girders substituted for the wooden trusses. The difference in cost, however (the one I preferred costing \$4,700 more than the other), caused me to hesitate before expressing my preference to the Committee; but, recalling the Solicitor's opinion, I felt it to be my duty to express to the Committee my reasons for preferring the more costly of the two plans, and, as

both were within the limit of \$60,000, let the Committee decide. By the terms of the Order the plans must be satisfactory to the City Engineer; and the Committee, feeling that they must be governed in the matter of selection by his choice, voted to recommend to the Board of Aldermen the passage of an order authorizing the Committee on Bridges to contract with Messrs. Ross and Lord for rebuilding Mt. Washington avenue bridge, piers and abutments in accordance with plans and specifications submitted by them and approved by the City Engineer, for the sum of \$56,000.

An order was accordingly introduced in Board of Aldermen that afternoon, and after long discussion was recommitted.

July 25th. The same order was reported back by a majority of the Committee, and after being discussed considerably, was passed.

I have been more prolix, perhaps, in reciting the history of this matter than the subject itself would warrant; but, recalling the somewhat heated controversies in relation to it, and the insinuations of favoritism, if not unfairness, in awarding the contract, or rather in making the selection, — and desiring to correct, if possible, the effect of some inaccuracies of statement made during the discussions of the matter, I have felt it to be my duty in this connection to state the facts in the case as they actually were.

The whole difficulty in this matter was well stated by a member of the Board of Aldermen during the discussion when he said, "that, by allowing the adoption of this amendment, the difficulty had arisen of everybody bidding upon his own plans without competition."

The contract with Messrs. Ross & Lord was signed August 11th, the understanding being that the bridge was to be closed to public travel so that work could be commenced Aug. 20th and finished Dec. 1st; but, to accommodate certain special business on Boston Wharf, the time for closing the bridge was

postponed so that the contractor was delayed about a month. The work is nearly completed. The approaches to the draw are finished and the iron girders of the new draw are in position.

The plan of repairs is substantially the same as the one originally proposed by me, the modifications being very slight. The top surface of the bridge at the draw has been raised three feet, and the approaches finished on a grade falling each way from the draw at the rate of $1\frac{5.8}{100}$ feet per hundred. The bridge was stripped of everything above the stringers, and a new pile driven in each pier between the old ones, making seven new piles to each pier. The new piles were capped with a 14" \times 14" hard pine cap at a suitable height above the old caps to conform to the new grade. New stringers were put on the new cap over the old stringers and supported at two intermediate points in each bay upon the old stringer by hard pine posts or struts properly tenoned and secured; thus keeping the strength of both. The flooring is of six-inch Burnettized spruce covered with a water-tight covering of asphaltum concrete, and crowned in the middle of roadway. The contract required that, upon this concrete there should be placed a pavement of wooden blocks; but objections being subsequently raised by truckmen using the bridge a good deal for heavy travel, that wood pavement in that place would be very objectionable, authority was given the Committee to amend the contract and substitute small granite blocks for the wood.

The change was accordingly made and the bridge is paved with stone. The curbs are of cast-iron similar to those of the Berkeley street and the Broadway extension bridges. New oak ribbons have been put on each side of the draw-pier and said piers are entirely replanked. New piles have been driven and the piers strengthened at the ends. Additional piles have also been driven under the centre of drawbridge, in front of the abutments at each end of the bridge, and at several other points where the old ones were deemed by the Engineer unfit

to remain. A portion of the southerly abutment was relaid, and the northerly one was thoroughly braced with oak piles at its base.

The fender guard has been strengthened and recapped, and, in short, the entire bridge above the old stringers has been rebuilt in a most thorough and substantial manner.

The drawbridge is entirely new above the piling and platform, and is placed about three feet higher than the old one so as to keep the tracks and wheels out of the reach of tide water and ice as before stated. The general plan is precisely the same as my original one, except that in place of the trusses of wood there are substituted plate iron girders. These main girders are one hundred thirty-six feet long and support the entire roadway and sidewalks; they are eight feet high in the centre, and three feet at the ends. These girders rest at their centres, upon the ends of a plate-iron box-girder, composed of three vertical plates or webs, connected at top and bottom with horizontal plates and angle irons, and having vertical and diagonal angle-iron stiffeners and interior cross bracing. This cross girder is proportioned to carry the entire weight of the bridge — one half resting on each end — and transmit the same to a centre pivot, eight inches in diameter, and provided with a screw so that the entire weight of the bridge may be borne by the centre pivot. A turn-table with tracks and wheels in the usual style is provided; but it is designed to carry the bulk of the weight upon the pivot, the wheels to take only enough to keep the bridge steady. It is anticipated that this arrangement will be superior to any of the plans in use on the other bridges, where the bulk of the weight rests upon the wheels and generally upon one or two.

The original contract price for doing this work was \$56,000.00; the Committee were subsequently authorized to expend \$3,200.00 additional for Burnettizing plank, and substituting stone pavement for wood.

The amount paid on this contract to Jan. 1st, 1871, is \$40,404.00.

ALBANY STREET BRIDGE (OVER BOSTON AND ALBANY R. R.).

This structure is in good condition as to safety; but the entire iron work should be repainted. The abutments have cracked badly, and present an appearance of instability; but there has been no settling, and the cracks were occasioned by a slight spreading of the wing, or retaining walls, which are bonded into the abutments. These wing walls were not ballasted, and the filling of the street in the rear with objectionable material, and its subsequent settlement has pressed these walls out, carrying portions of the abutments with them. The movement has ceased, and has not amounted to enough to injure the stability of the walls or abutment in the least.

FERDINAND STREET BRIDGE (OVER B. AND A. R. R.).

Nothing has been done to this bridge during the year except to replank it. The iron work should be repainted, and the approach on the northerly side replanked.

BERKELEY STREET BRIDGE (OVER B. AND A. R. R.).

The roadway has been partially replanked and raised; but the horse railroad tracks remain at the old level. These should be raised so that the surface of the roadway may be uniform. As it is, it not only looks badly, but is unsafe. The web of the middle girder is badly rusted, and should be thoroughly scraped, cleaned, and painted. The web-plates are only one-tenth of an inch in thickness, and the attachments none too strong; hence the necessity of preserving the little iron there is, and not allowing it to rust away. Painting over rust and mud will do little good; the iron should be clean when the paint is applied. The space between the wooden curb and the web of the girders, should be filled in, as it is now only a receptacle for mud and filth, which comes directly in contact with the iron of the webs where the lower ^hcord attachments are made.

BERKELEY STREET BRIDGE (OVER BOSTON AND PROVIDENCE R. R.).

The superstructure is in good condition. The abutment on the southerly side has settled and cracked badly at the east end, and slightly at the west end. Some iron cramps properly applied would prevent a further movement.

COLUMBUS AVE. BRIDGE (OVER B. AND A. R. R.).

This bridge has been replanked; but not enough longitudinal crown was given to shed properly the rainfall. The lower ^h cords and all the iron work beneath the floor should be painted.

DARTMOUTH STREET BRIDGE (OVER B. AND A. AND B. AND P. R. R.
AT THEIR JUNCTION).

This bridge is in good order, and will need no repairs this year.

DORCHESTER STREET BRIDGE (OVER O. C. AND N. R. R.).

This bridge is in good condition, having required no repairs during the year. Some slight alterations, however, were made in order to lay the new twenty-inch main for South Boston.

NEW FERRY DROP (EAST BOSTON FERRY).

Plans and specifications for a new ferry drop and tank were prepared in the summer by request of the Directors, and the drop has since been built in conformity with said plans. It is a stronger and better structure than any built hitherto, and gives good satisfaction.

Respectfully submitted.

N. HENRY CRAFTS,
City Engineer.

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